# A LIMITED ENERGY STUDY OF HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS AT FORT STEWART AND HUNTER ARMY AIRFIELD, GEORGIA

## VOLUME I
## NARRATIVE REPORT

## FINAL SUBMITTAL

Prepared For
Savannah District, Corps of Engineers

Contract Number DACA01-94-D-0038
Delivery Order Number 0002

Prepared by
Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000

Carlos S. Warren, PhD, PE
Project Manager

William T. Todd, PE
Field Survey Manager



September 6, 1996

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| Forces Command | 3rd Infantry Division Fort Stewart | Savannah District Corps of Engineers | Reynolds, Smith and Hills, Inc. |

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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# 1.0 INTRODUCTION

## 1.1 AUTHORIZATION

Architectural-engineering services for the Energy Engineering Analysis Program (EEAP) - Southeast Region were authorized by the US Army Corps of Engineers, Mobile District Contracting Division under Indefinite Delivery Contract Number DACA01-94-D-0038. Engineering services for the Limited Energy Study of High Temperature and Chilled Water Distribution Systems at Fort Stewart and Hunter Army Airfield were authorized by Delivery Order Number 2 from the Savannah District, Corps of Engineers. Reynolds, Smith and Hills, Inc. (RS&H) received the Notice to Proceed for Delivery Order Number 2 on June 15, 1995.

## 1.2 OBJECTIVES

The primary purpose of this contract is to conduct a detailed study that will determine the location and quantity of losses from the High Temperature Water (HTW) distribution system at Fort Stewart. A copy of the Scope of Work for this project is contained in the Appendix. This study includes a comprehensive field investigation of the energy plants, distribution system piping and end-use systems, identification of Energy Conservation Opportunities (ECOs), energy savings calculations and economic analysis of the ECOs.

This project also includes interviews with operation and maintenance personnel, review of records and recommendations on whether further study is required on the chilled water distribution system at Fort Stewart and the high temperature water and chilled water distribution systems at Hunter Army Airfield. The results of our analysis and the recommendations are contained in the Records Analysis and Site Survey Plan which was submitted on August 28, 1995 and is included with this report as Appendix A.10.

## 1.3 WORK ACCOMPLISHED

The entry interview was conducted at the Fort Stewart Department of Public Works (DPW) office on June 28, 1995. The meeting minutes and all other project related correspondence is contained in Appendix A.9.

RS&H conducted the initial field investigation, personnel interviews and data collection at Fort Stewart and Hunter Army Airfield on August 3-4, 1995. The results of the preliminary analysis, recommendations for further studies and the detailed field investigation plan for the Fort Stewart HTW distribution system are contained in the Records Analysis and Site Survey Plan submitted on August 28, 1995.

Subsequent comprehensive field investigations that were performed include:

- Survey of the Central Energy Plant (CEP) and collection of samples of domestic hot water from October 2-6, 1995.

- Survey of the CEP, Satellite Energy Plant (SEP), valve pits and mechanical equipment rooms from November 27, 1995 through December 1, 1995.

- Survey of the mechanical equipment rooms and domestic hot water generators from January 16-18, 1996.

- Survey of selected sections of the underground HTW distribution pipes from February 21-23, 1996.

The Interim Report was submitted on February 19, 1996. The Interim Submittal Presentation and Review Conference was held in the Fort Stewart DPW Conference Room on April 17, 1996. The Pre-Final Report was submitted on May 31, 1996. A copy of all comments received are contained in Appendix A.7. The results of these comments are incorporated in this submittal.

Energy, water and labor savings calculations, cost estimates and economic analyses have been completed for all of the ECOs. This report contains the field investigation methodology, data analysis, project evaluations, evaluation results, recommendations and project documentation for the HTW distribution system at Fort Stewart. A list of abbreviations and acronyms used in this report is located in Appendix A.8.

# 2.0 FACILITY DESCRIPTION

## 2.1 GENERAL DESCRIPTION

Fort Stewart is located near Hinesville, Georgia, which is approximately 30 miles southwest of Savannah. The installation is the headquarters for the 3rd Infantry Division, Mechanized. Most of the buildings are barracks, troop support facilities and vehicle maintenance facilities.

## 2.2 CENTRAL ENERGY PLANT

The CEP is located in Building No. 1412 and contains boilers that produce high pressure steam (HPS) from which the HTW is produced. Steam for all of the HTW production systems and the HTW for distribution Zones 1, 2 and 3 are produced in the CEP. The steam generation system consists of three natural gas/fuel oil-fired package boilers and one stoker-fired wood boiler. These boilers are manifolded together and produce 200 pound per square inch gauge (psig) steam. This HPS is injected directly into the high temperature water return (HTWR) inside large metal tanks (cascade heaters). The heated HTWR becomes high temperature water supply (HTWS) in the three cascade heaters. The HTWS leaves the cascade heaters at a temperature of approximately 380 degrees F and a pressure of about 200 psig.

The HTWS is piped to three circulating pumps and is then distributed to the various buildings via the underground HTW distribution system piping. The HPS is also piped approximately one mile to two additional cascade heaters located in the SEP. A schematic flow diagram of the CEP and the SEP HTW generation systems is presented by Figure 2.2-1. A HTW distribution system map showing all of the HTW zone piping, valve pits and buildings served is contained in Appendix A.2.

## 2.3 SATELLITE ENERGY PLANT

The satellite energy plant contains two cascade heaters and one pair of circulating pumps. Steam from the CEP feeds the cascade heaters to produce HTW for the SEP distribution zone. Circulating pumps distribute the HTW to the five buildings in the SEP distribution zone. These buildings only require HTW for space heating, therefore, the SEP only operates during the heating season. The SEP is brought on line when the weather turns cold, typically in October or November. The SEP is shut down when the weather moderates, usually by late February or early March of the following year. There are also two chillers in the SEP that are not operated. The chillers and cascade heaters were sized and installed based on plans for tremendous expansion in the future.

absorption or centrifugal?

## 2.4 HTW DISTRIBUTION SYSTEMS

The HTWS is pumped from the CEP and SEP through the underground HTW distribution system piping. This piping is black steel with welded joints and flanged valves. The HTW piping and insulation are enclosed in a

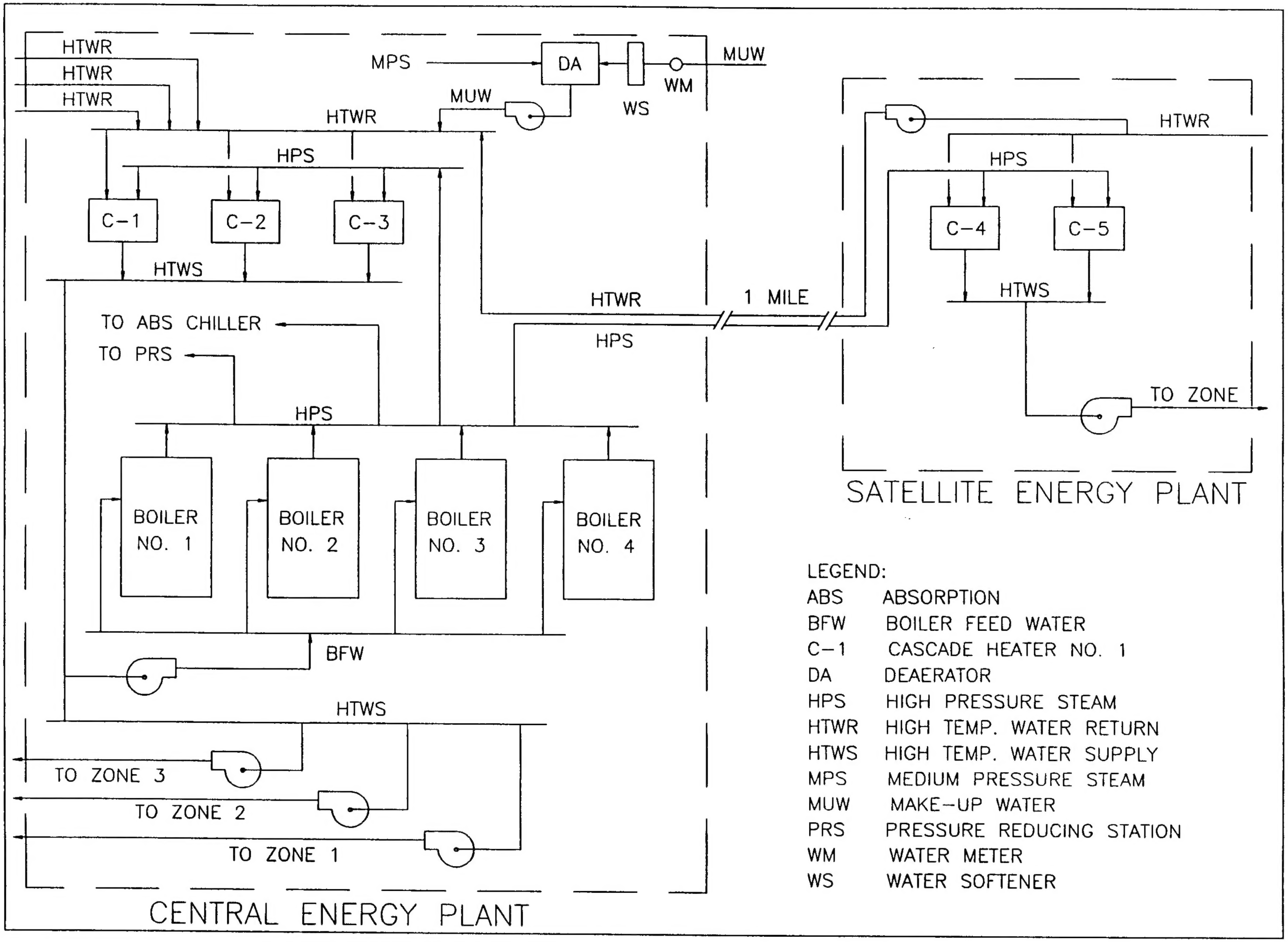



Figure 2.2-1 SCHEMATIC FLOW DIAGRAM

metal conduit, which is buried approximately four to six feet below the surface. There are U-shaped expansion joints throughout the HTW supply and return distribution systems.

There are four HTW distribution system zones that provide the heating source for many of the buildings at Fort Stewart. Three of the zones (Zones 1, 2 and 3) emanate from the CEP. The Zone 2 distribution system splits shortly after leaving the Central Energy Plant and serves some buildings to the north (Zone 2N) and some buildings to the south (Zone 2S). The fourth distribution system comes from the Satellite Energy Plant. Basic information on each of the HTW distribution system zones is presented in the following table.

**Table 2.4-1 HTW DISTRIBUTION SYSTEM INFORMATION**

| | ZONE 1 | ZONE 2N | ZONE 2S | ZONE 3 | SEP ZONE |
|---|---|---|---|---|---|
| Length (Miles) | 1.7 | 0.9 | 1.3 | 3.3 | 1.7 * |
| No. Valve Pits | 19 | 9 | 15 | 38 | 14 |
| No. Exp. Joints | 29 | 26 | 19 | 69 | 29 |
| No. Buildings | 70 | 9 | 23 | 26 | 5 |

* Includes approximately 0.9 miles of steam supply piping.

The HTW supply and return piping for each of the zones are closed systems. Various types of heat exchangers are used within the buildings to produce domestic hot water (DHW), space heating and low pressure steam (LPS). The Tactical Equipment Shops and administrative buildings utilize the HTW for space heating, barracks and dining facilities utilize the HTW for space heating and domestic hot water, and LPS is used at the dining facilities for cooking and warming of food. All of these heating processes are closed systems, which means no HTW is used directly by the heating equipment, therefore no HTW is discharged down a drain.

Temperature control of the DHW and space heating equipment is accomplished by two-way control valves located on the HTWR piping leaving the various heat exchange equipment. The circulating pumps for the various HTW zones utilize pressure controlled, hydraulic, variable speed drives to regulate the flow to each zone.

# 3.0 METHODOLOGY

## 3.1 GENERAL

The objective of this project is to determine the location and quantity of HTW distribution system piping losses. The total HTW system losses are comprised of these underground piping losses as well as the following: boiler/cascade heater blowdown, soot blowing, leaks associated with Boiler No. 4, CEP leaks, SEP leaks, valve and fitting leaks in valve pits and mechanical equipment room leaks. The field investigation plan was developed to locate and quantify all of these losses.

The field investigation was undertaken and accomplished in three phases. The objective of the first phase was to determine as accurately as possible how much HTW is leaking from the entire HTW system. This was accomplished by surveying the CEP and SEP and measuring and estimating the mass flows into and out of the HTW system. The first phase also included surveys of mechanical equipment rooms to determine how much of the HTW losses are occurring within the buildings served by the HTW system.

Valve pits, drain pits and valve boxes were inspected during the second phase of the field survey effort. This survey determined the location of leaking valves and fittings and also isolated sections of the underground distribution piping where leaks may be occurring. The amount of HTW leaking from the various valves and fittings was also estimated or measured.

The final phase of the field investigation was to pinpoint and quantify the leaks within the underground HTW distribution system piping. The detailed field investigation plans and schedule of events are presented in the following pages.

## 3.2 QUANTIFY HTW LOSSES

### Central Energy Plant

The HTW distribution and return system is a closed system, which means that no HTW is consumed by the end-use equipment. The known system losses are steam soot blowing, boiler blowdown, cascade heater blowdown, the deaerator vent and other miscellaneous leaks within the CEP. The total quantity of leaks are estimated by closing all of the soot blowing and blowdown valves and then measuring the flow of makeup water into the HTW system. The amount of makeup water added to the HTW system is a direct indication of how much HTW is leaking out of the system.

The procedure for estimating the HTW losses from the CEP and the distribution system for Zones 1, 2 and 3 was:

1. Fill the system (cascade heaters) to the maximum operating level (i.e., half full). Note the time and make-up water meter totalizer reading.

2. Operate the CEP normally for eight hours except do not operate the soot blowers and do not blowdown the boilers or the cascade heaters.

3. Keep the water levels in the cascade heaters within acceptable limits.

4. Near the end of the eight-hour period, fill the cascade heaters to the starting level. Record the time and make-up water meter totalizer reading.

5. The difference in the make-up water totalizer readings divided by the elapsed time is equal to the HTW loss rate due to leaks in the CEP and the distribution system for Zones 1, 2 and 3.

The estimated loss rate from the above procedure was used to validate our estimate of the annual average HTW losses from the CEP and the distribution system for Zones 1, 2 and 3. → Read on.

The total HTW system losses are equal to the total HTW make-up water. Daily HTW system make-up water data were obtained from the CEP boiler operation logs for calendar year (CY) 93, CY94 and CY95 and are located in Appendix A.5. These data were statistically analyzed and the results are contained in Section 4.2. The annual average HTW make-up water for CY95 was used in calculations as the total HTW system losses. The amount of water used for blowdown and soot blowing must be subtracted from the amount of HTW system makeup water to determine the HTW distribution system losses. Therefore, the CEP survey included estimating the soot blowing losses and the continuous and intermittent blowdown from all boilers and cascade heaters. A discussion on boiler blowdown and soot blowing along with estimates of their water consumption is contained in Section 4.2.

Pipe sizes and lengths were read from the HTW distribution system maps and were used to estimate the total quantity of HTW in the supply and return distribution systems. The total HTW volume was then used to determine what percentage of the total volume is lost by leaks in the distribution system. The calculations and assumptions used are contained in Appendix A.4.

Pressures shown on the pressure gauges at the supply pumps for all three of the CEP HTW distribution zones were read and recorded. This data and the information from the nameplates on the pumps and pump motors are contained in Appendix B.3.

Copies of the boiler water, boiler feed water and HTW supply water analysis reports were obtained and reviewed. These reports were used to verify and compare with the samples taken from the various domestic hot water systems in the buildings served by the HTW system. The comparisons were used to determine if any of the heat exchangers in the hot water generators may have failed. A writeup on the survey of mechanical equipment rooms contains additional information and is located later in this section.

**Satellite Energy Plant (SEP)**

There is no direct fresh or treated makeup water feed to the SEP HTW distribution system. The water level in the two SEP cascade heaters is manually checked three times per day (once each shift). When the water level in the cascade heaters drops below a certain value, the CEP operators use the HTW system return pipes to "back fill" the SEP cascade heaters.

The SEP HTW distribution and return system is also a closed system. The known system loss is the blowdown from the cascade heaters. The total quantity of leaks were estimated by closing all of the blowdown valves and then measuring the amount of HTW lost from the cascade heaters over a two-hour time period. The amount of HTW losses from the two cascade heaters is a direct indication of how much HTW is leaking out of the SEP distribution system.

The procedure for estimating the HTW losses from the SEP and its distribution system was:

1. Fill the system (two cascade heaters) to the maximum operating level. Note the time and mark the water level on the sight glasses of the cascade heaters.

2. Stop all steam flow from the CEP to the SEP (a valve at the CEP was used to shut off the steam). Stop all HTW return flow from the SEP to the CEP.

3. Operate the SEP normally for two hours except do not blowdown the cascade heaters.

4. Keep the water levels in the cascade heaters within acceptable limits.

5. At the end of the two-hour period, mark the water level on the sight glasses of the cascade heaters and measure the height to the starting level. Record the time and decrease in water level.

6. Calculate the volume change (gallons) in the cascade heaters and divide that figure by the elapsed time. The value obtained is equal to the HTW loss rate due to leaks in the SEP and its distribution system.

The amount of water used for blowdown and other miscellaneous leaks must be added to the estimated loss rate from the above procedure to determine the total HTW losses from the SEP.

Pressures shown on the pressure gauges at the SEP zone HTW supply pumps were read and recorded. This data and the information from the nameplates on the pumps and pump motors are contained in Appendix B.3.

**Valve Pits, Drain Pits and Valve Boxes**

There are approximately 95 valve pits located along the main HTW and chilled water (CHW) supply and return lines. The valve pits were visually checked for HTW and CHW leaks around all of the valve stems, flanges and fittings. The volume of flow from each significant leak found was estimated or measured using a beaker and stopwatch.

Steam flowing from the conduit vents on HTW lines where they enter and exit the valve pit indicates a possible leak in the HTW piping. This information was noted and used to isolate sections of the HTW piping for the leak detection and leak locating effort.

Valves and fittings typically found in the valve pits include globe valves on all HTW mains and take offs, plug valves on all CHW mains and take offs, drain valves (two gate valves for each CHW main valve and two globe valves for each HTW main valve) and two globe valves and an air bottle on each line vent. If there was standing water in the bottom of the pit, a notation was made indicating that the sump pump is not working properly.

Drain pits are located at low points along the main HTW and CHW supply and return lines. The drain pits were visually checked for HTW and CHW leaks around all of the valve stems, flanges and fittings. The volume of flow from each significant leak was estimated.

Steam flowing from the conduit vents on HTW lines where they enter and exit the drain pit indicates a possible leak in the HTW piping. This information was noted and used to isolate sections of the HTW piping for the leak detection and leak locating effort.

Typically, there is one globe valve on each HTW supply and return line. If there was standing water in the bottom of the pit, a notation was made indicating that the sump pump is not working properly.

Valve boxes are located at high points along the main HTW and CHW supply and return lines. There are typically two HTW and two CHW risers in each valve box and two globe valves and one air bottle on each riser.

Some of the valve boxes were visually checked for HTW and CHW leaks around all of the valve stems, flanges and fittings. The volume of flow from each significant leak was estimated.

**Mechanical Equipment Rooms**

A survey of the mechanical equipment rooms was not included in the original Scope of Work. However, several HTW leaks from valve stems and flanges were found during a random survey of some of the mechanical equipment rooms. This prompted us to schedule surveys of the mechanical equipment rooms in all of the 133 buildings served by the HTW distribution system.

The survey of mechanical equipment rooms included checking for HTW leaks around the valve stems, flanges and fittings for the HTW supply and return lines to and from the heat exchangers for the hot water generators, HVAC systems and steam generators. The volume of flow from each significant leak was measured using a graduated beaker and a stopwatch.

A sample of the domestic hot water was obtained from each building that utilizes the HTW system to heat the domestic hot water. The domestic hot water supply temperature was also measured and recorded. The domestic hot water source was allowed to flow for a sufficient time prior to sampling to ensure the sample was not diluted with potable cold water. The samples were taken during a time when the building's domestic hot water systems were not being heavily utilized, typically between 0900 hours and 1500 hours.

These samples were analyzed for conductivity, pH, phosphate, sulfate and iron by a laboratory. The laboratory analysis was compared to the analysis of the HTW and the Fort Stewart potable water supply. If chemicals or compounds that are usually only present in the HTW were found in the domestic hot water, then the heat exchanger has probably failed and is leaking. Copies of the water sample analyses and the statistical analysis used to indicate possible leaks are contained in Appendix A.6.

A high domestic hot water temperature usually means there is a control problem. However, it can also indicate a HTW leak from the heat exchanger inside the DHW generator. The HTW control valves are located on the HTW return side of the hot water generators. Therefore, even if the thermostat is satisfied and the control valve is completely closed, the DHW temperature will continue to rise if the heat exchanger is leaking HTW within the DHW generator.

## 3.3 LOCATE LEAKS IN THE UNDERGROUND HTW PIPING

Once these sections of piping were identified, the use of infrared thermography was considered to locate "hot spots" at ground level along the HTW distribution piping. The hot spots would indicate areas of the piping where the pipe insulation has become saturated and is no longer effective. There are two possible causes of the hot

spots. Either the outer conduit has failed and the insulation has become soaked with groundwater or a leak in the HTW pipe has caused the insulation to become saturated with HTW. An aerial infrared thermographic investigation for the HTW system at Fort Stewart would cost approximately $40,000. Fort Stewart would receive some benefit from this type of survey; however, based on the low distribution system losses at this time, the cost greatly exceeds the benefit.

Information obtained during the survey of the valve pits was used to isolate sections of the HTW distribution system suspected of having leaks. The sections of HTW piping suspected of having leaks were systematically surveyed with an electronic leak detection system in an effort to determine as accurately as possible the location of all distribution system leaks. A leak in the HTW piping allows the pressurized fluid to escape. The escaping fluid creates sound frequencies which travel along the pipe.

The leak location technique utilizes two acoustical leak detectors that amplify the audio signals of the leaks and a microprocessor based leak locator. Each leak detector has a radio transmitter with a unique sound channel. Contact is established between the leak detector transducers and the HTW valves at two valve pits that flank a suspected leak. The radio transmitters send audio signals to the microprocessor based leak locator that is situated between the two valve pits.

Distribution information including pipe size and type and measured distance of pipe between the two valve pits are entered into the leak locator. Initialize the leak locator and the leak signals are processed by the computer. Leak position is shown and evaluated on a video display. The exact location of the leak and the distance from the valve pits to the leak are calculated. The amount of HTW escaping from each leak can be estimated by the audible signal of the leak detectors.

The distance from the valve pit to the leak is then measured off and the location of the leak is marked.

### 3.4 FIELD INVESTIGATION SCHEDULE

The following schedule shows the dates when the field investigations were performed and the tasks accomplished during each site visit.

| **Week Ending** | **Tasks Accomplished** |
|---|---|
| August 4, 1995 | - Obtained data, drawings and maintenance records for the HTW and CHW systems at Fort Stewart and Hunter Army Airfield. |
| | - Conducted interviews with Department of Public Works Personnel at Fort Stewart and Hunter Army Airfield. |

- Performed preliminary survey of CEP, valve pits and mechanical equipment rooms at Fort Stewart.

August 28, 1995
- Submitted Records Analysis and Site Survey Plan for the HTW and CHW systems at Fort Stewart and Hunter Army Airfield for review and comment.

September 15, 1995
- Located HTW make-up water, chemical feed and blowdown pipes to be metered.
- Obtained copies of recent HTW sample analysis reports from the CEP and potable water analysis reports from the water plant.
- Sent progress report to Fort Stewart Energy Officer (FSEO) and Savannah Corps of Engineers.

October 6, 1995
- Performed survey of the CEP. Measured the HTW make-up water and estimated the volume of blowdown water during nonheating season conditions. Recorded pump and motor data.
- Measured DHW temperatures and obtained samples of the DHW in buildings served by the HTW system.
- Sent progress report to FSEO and Savannah Corps of Engineers.

December 1, 1995
- Surveyed the valve pits, drain pits and valve boxes.
- Surveyed mechanical equipment rooms in buildings served by the HTW system.
- Surveyed the CEP and the SEP. Measured the HTW make-up water and estimated the volume of blowdown water during heating season conditions. Recorded pump and motor data.
- Sent progress report to FSEO and Savannah Corps of Engineers.

January 19, 1996
- Surveyed the remaining mechanical equipment rooms in buildings served by the HTW system.
- Sent progress report to FSEO and Savannah Corps of Engineers.

February 23, 1996
- Surveyed selected sections of the underground HTW supply and return distribution lines using leak correlate equipment.
- Sent progress report to FSEO and Savannah Corps of Engineers.

## 3.5 UTILITY RATES

The utility rates used for the energy cost savings calculations and the economic analysis are presented in the following table. The source that provided the utility information is also listed in the table.

| Table 3.5-1 FORT STEWART UTILITY RATES | | |
|---|---|---|
| **UTILITY** | **RATE** | **SOURCE** |
| Electricity | $0.0469/kWh, $13.74/MBtu | Georgia Power Co. Bills |
| CEP Heating Fuels (Avg) | $1.34/MBtu | Calc. From 12 Months Data |
| Fuel Oil | $0.62/Gal, $4.40/MBtu | DPW Monthly Oil Reports |
| Used (Waste) Oil | $0.0/Gal, $0.0/MBtu | DPW Service Branch |
| Wood | $10.82/Ton, $1.04/MBtu* | DPW Service Branch |
| Natural Gas | $3.04/MCF, $2.98/MBtu | Atlanta Gas Light Co. Bills |
| Potable Water | $0.5562/1,000 Gallons | DPW Service Branch |

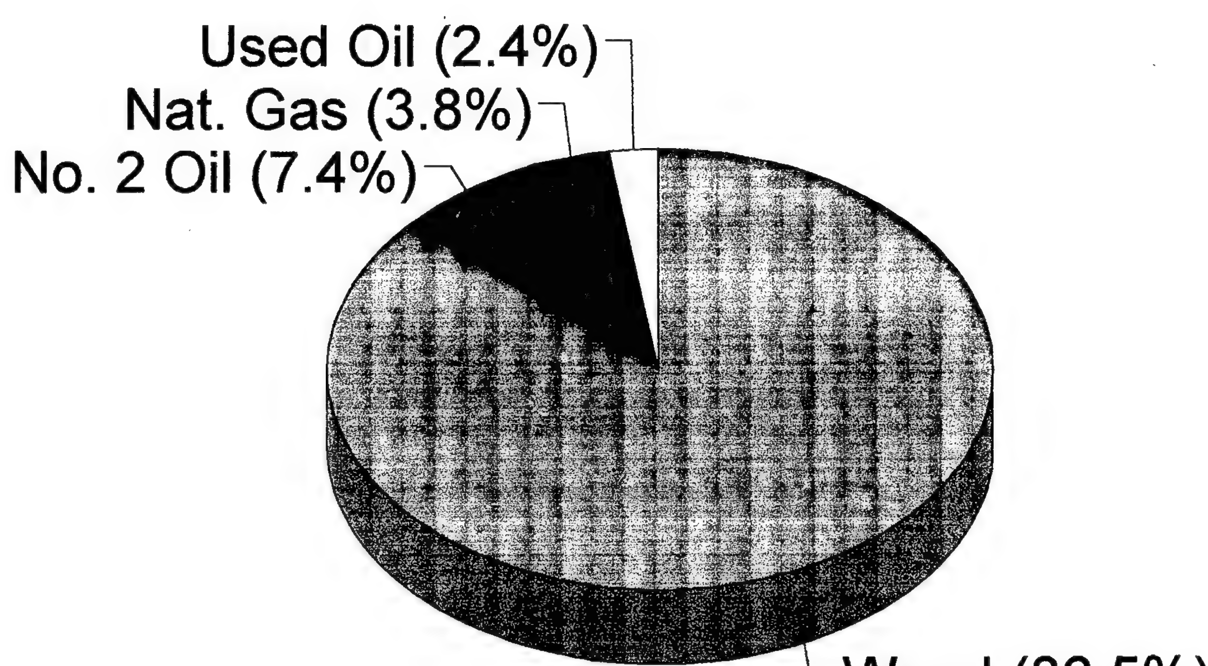
* Assumes a moisture content of 40 percent and a heating value of 5,200 Btu/lb.

The CEP heating fuels rate is an average value calculated from 12 months of CEP energy use data. The CEP heating fuel use make-up is shown in Figure 3.5-1. Wood is by far the dominant fuel used at 87.5 percent, followed by No. 2 fuel oil at 7.4 percent, used oil (from the motor pool) at 2.4 percent and natural gas at 3.8 percent. The energy consumption and cost data is contained in Appendix A.5.

The utility rates are shown graphically by Figure 3.5-2. The cost of electricity is more than ten times the average cost of CEP heating fuels and the cost of fuel oil is more than three times the average cost of CEP heating fuels. The average cost of heating fuels used at the CEP is very low due to the large quantity of inexpensive wood they burn and the use of as much "free" used oil as they can get. Due to the low cost of the wood fuel, alternative heating sources for individual buildings will probably not be justified.

**Figure 3.5-1**

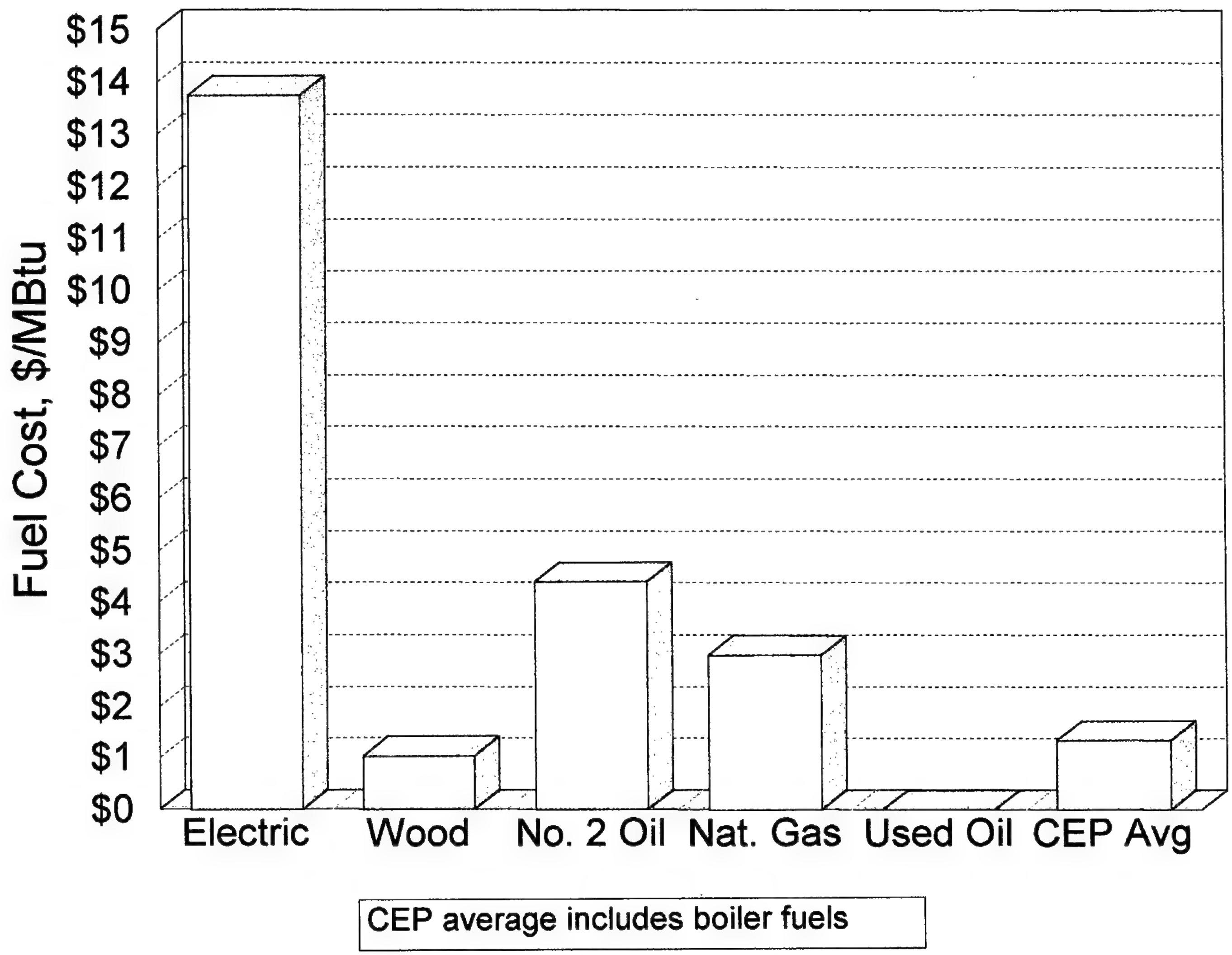
CEP Annual Fuel Consumption, 1994-1995




Total Fuel Consumption = 764,246 MBtu/Year

**Figure 3.5-2**

## Fort Stewart Utility Rates



# 4.0 ANALYSIS

## 4.1 HISTORICAL MAKE-UP WATER USE

Make-up water use at the central energy plant is metered as it leaves the water softeners. There are two make-up water meters with totalizers; one for each of the two water softeners. These totalizers for the meter or meters in use are read during each shift and the readings are added together to obtain the total daily make-up water value. The total daily make-up water values are recorded on the monthly Facilities Engineering Operating Log for the Central Energy Plant, Building 1412.

Copies of the monthly operating logs were obtained for CY93, CY94 and CY95. The daily make-up water values for these three years were input into a spreadsheet computer program. The spreadsheet computer program was used to statistically analyze the data, graphically show trends in the make-up water use and to obtain the average use for leak calculations and estimates.

Figure 4.1-1 shows the 1993 monthly make-up water use was fairly constant with use for ten of the 12 months averaging between five GPM (7,200 GPD) and ten GPM (14,400 GPD). There is a multiple-day spike in use during the end of August which possibly indicates a leak developed in HTW system and was subsequently repaired. Average make-up water use increased to about 11 GPM (15,900 GPD) in November and to 12 GPM (17,100 GPD) in December. This increase was probably due to the start up of the Satellite Energy Plant in November and an increase in leaks associated with the increased heating loads.

The frequency (number of days) that various make-up water flow rates occurred and the HTW make-up water statistical data for 1993 are shown in Figure 4.1-2. The make-up water use for 1993 averaged approximately 8.9 GPM (12,800 GPD). The standard deviation was 2.9 GPM and the variance was 8.3 GPM. There were a total of 15 days in 1993 that had a make-up water use of over 15 GPM (21,600 GPD).

The make-up water use for 1994 was much higher than 1993 and averaged approximately 14,500 GPD or 10.1 GPM. Figure 4.1-3 shows the monthly and daily make-up water use was very erratic. March had the maximum average monthly (18 GPM, 25,600 GPD) and daily (22 GPM, 31,800 GPD) make-up water use for the year. The Fort Stewart maintenance staff did not remember specific dates, however, they indicated there were two HTW leaks that occurred during this time frame. There was a HTW leak in the return line from the SEP to the CEP and there was another HTW leak in a pipe fitting near the 4500 block.

After March, the make-up water use dropped down to a more reasonable pattern from mid-April until the end of June. In July, the make-up water use was up to an average of 12 GPM (17,400 GPD). The staff recalled a problem with leaks within the boilers during this time. Average monthly make-up water use returned to a



2.2-1 Does not sh... a HTW Return line from SEP to CEP

Figure 4.1-1

# Fort Stewart HTW Make-up Water, 1993

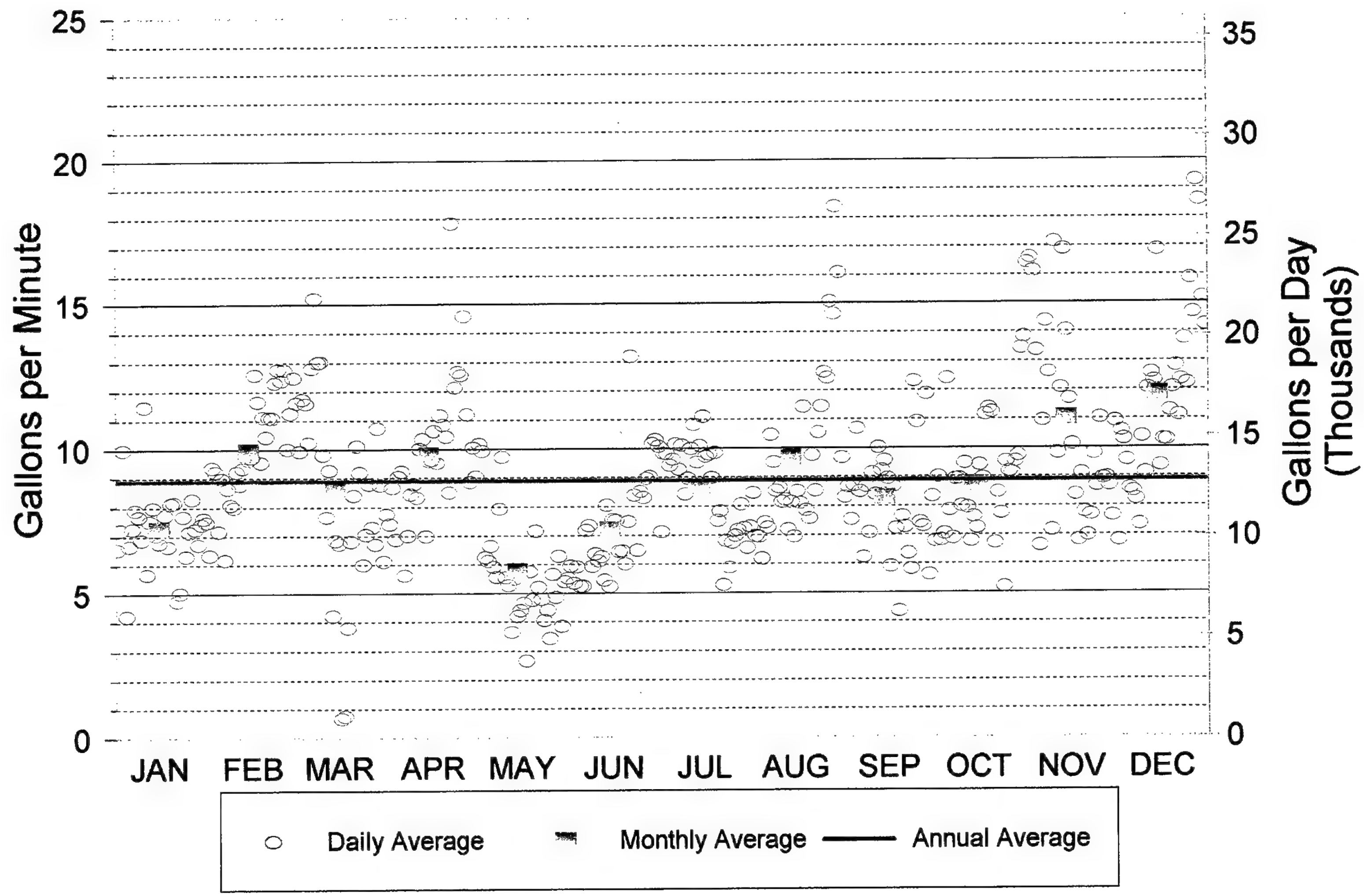
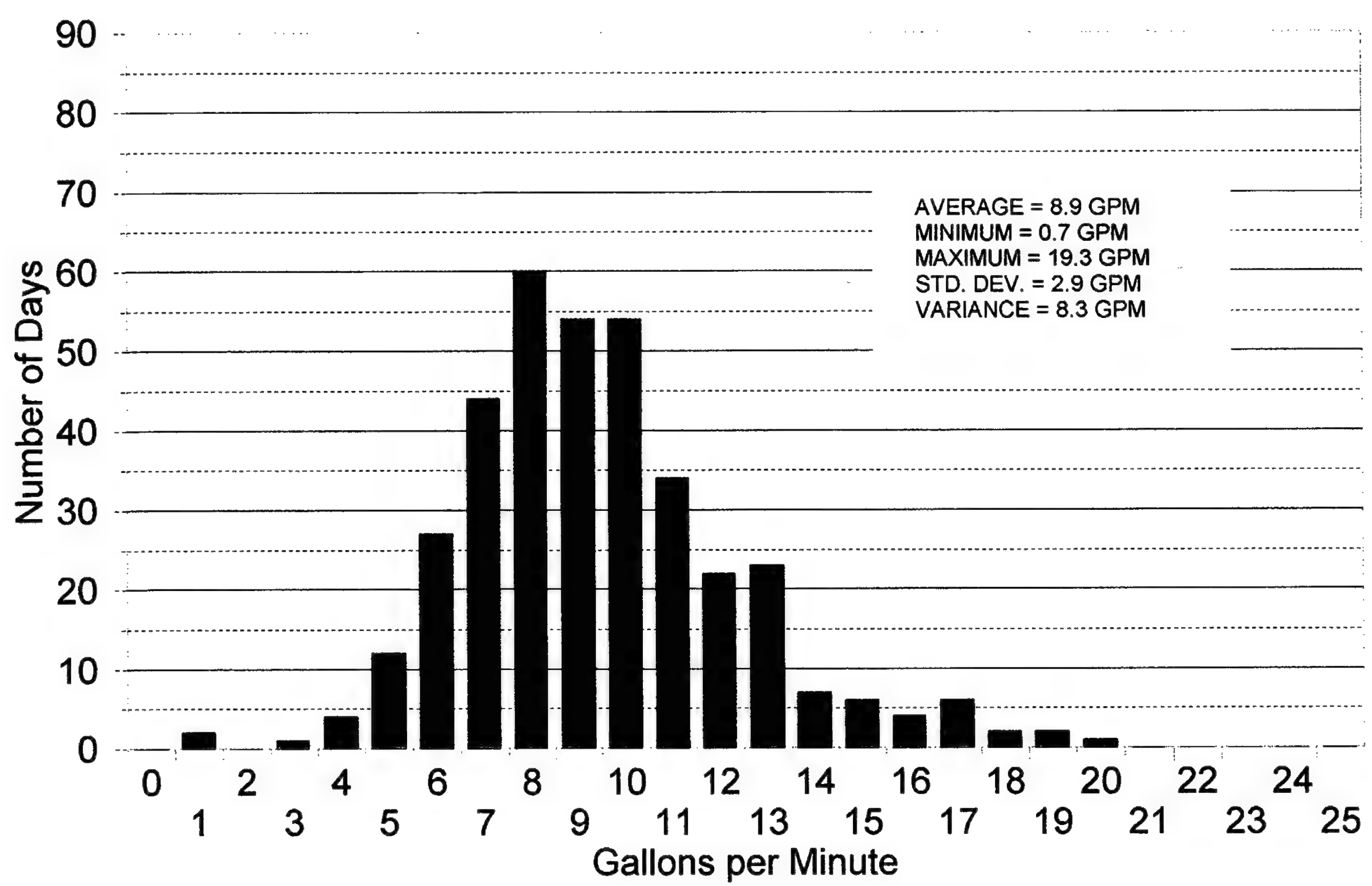


Figure 4.1-2

## HTW Make-up Water Statistics, 1993



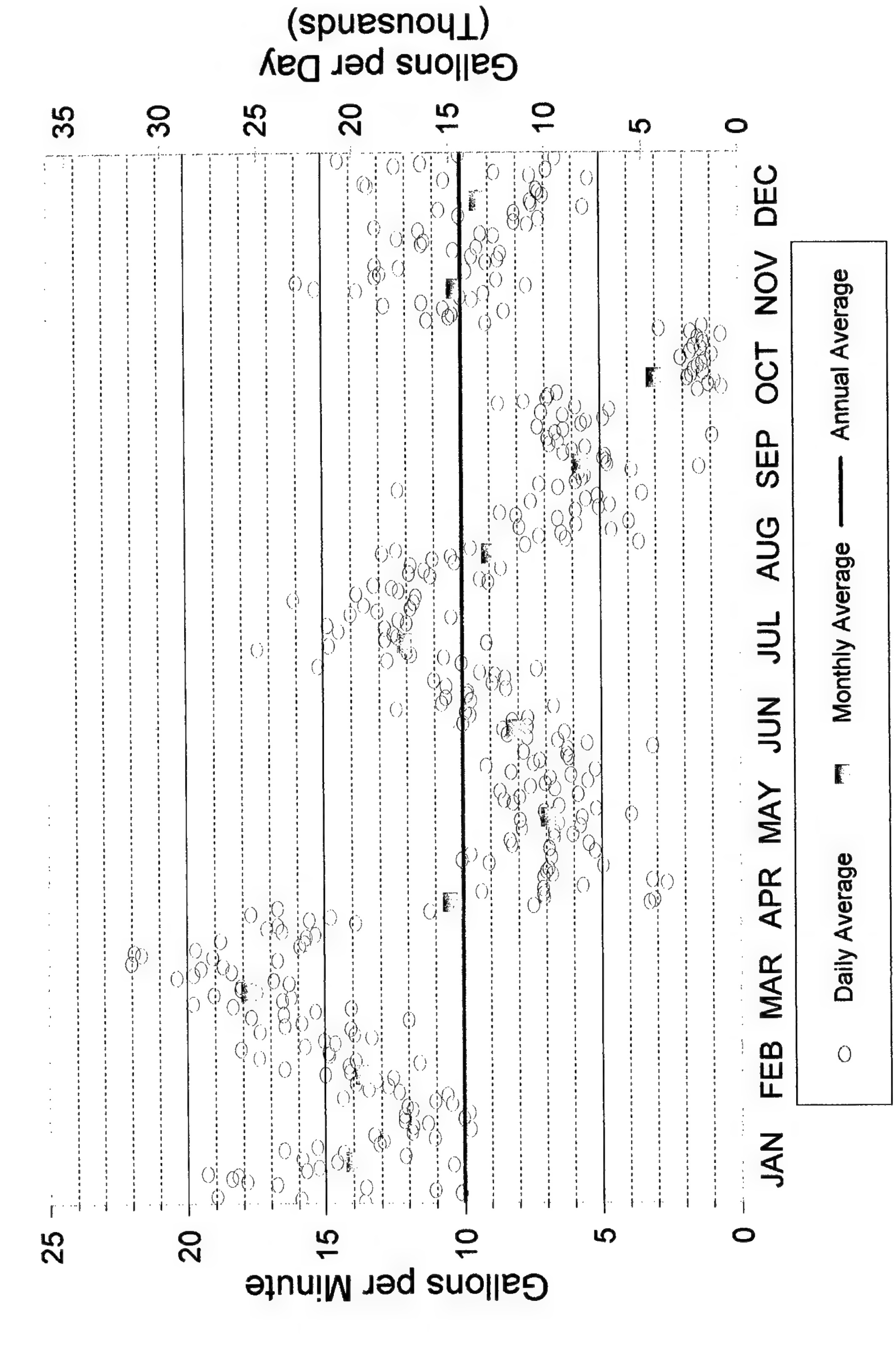



Figure 4.1-3
Fort Stewart HTW Make-up Water, 1994

more “normal” range for the rest of the year except for October. The make-up water values recorded for the last half of October were very low and are not accurate. There was a make-up water meter bypass valve partially open during this time period. The open valve was discovered and closed on the second day of November.

The frequency (number of days) that various make-up water flow rates occurred and the HTW make-up water statistical data for 1994 are shown in Figure 4.1-4. The make-up water use for 1994 averaged approximately 10.1 GPM (14,500 GPD). The standard deviation was 4.7 GPM and the variance was 22.1 GPM. There were a total of 66 days in 1994 that had a make-up water use of over 15 GPM (21,600 GPD). The concept for this study was originated during 1994 and these figures indicate that there was definitely reason to believe there were substantial leaks in the HTW system at that time.

Make-up water use was significantly lower in 1995 than the previous two years. Figure 4.1-5 shows the average monthly make-up water flow following a seasonal profile that would normally be expected. The losses (make-up flow) are higher during the high demand months of mid-winter (heating) and mid-summer (absorption cooling). Soot blowing, blowdown and other miscellaneous plant losses will usually be higher during times of high steam use. The baseline (low end) of the make-up water use for 1995 appears to be approximately 4.5 GPM.

Figure 4.1-5 also shows three high spikes in the make-up water use. Conversations with the CEP staff revealed the reasons for the three periods of unusually high water losses. The first one occurred on February 15. The make-up water use for that day was 25,150 gallons and was caused by a leak in the SEP zone. The second high-use point occurred on February 27. The make-up water use for that day was 24,830 gallons and was due to a leak in the HTW line in the 600 block. The third high make-up water use peak was caused by the water dumped during the SEP startup. The daily make-up water use during the startup period from November 13 through November 23 ranged from 10,000 gallons to 16,200 gallons. These values are 800 to 7,000 gallons higher than the average use for 1995.

The frequency (number of days) that the various make-up water flow rates occurred and the HTW make-up water statistical data for 1995 are shown in Figure 4.1-6. The make-up water use for 1995 averaged approximately 6.4 GPM (9,200 GPD). The standard deviation was down from 4.7 in 1994 to 2.5 GPM and the variance was 6.0 GPM. There were two days in 1995 that had a make-up water use of over 15 GPM (21,600 GPD) and they were both due to known leaks in the HTW system.

Figure 4.1-4

# HTW Make-up Water Statistics, 1994

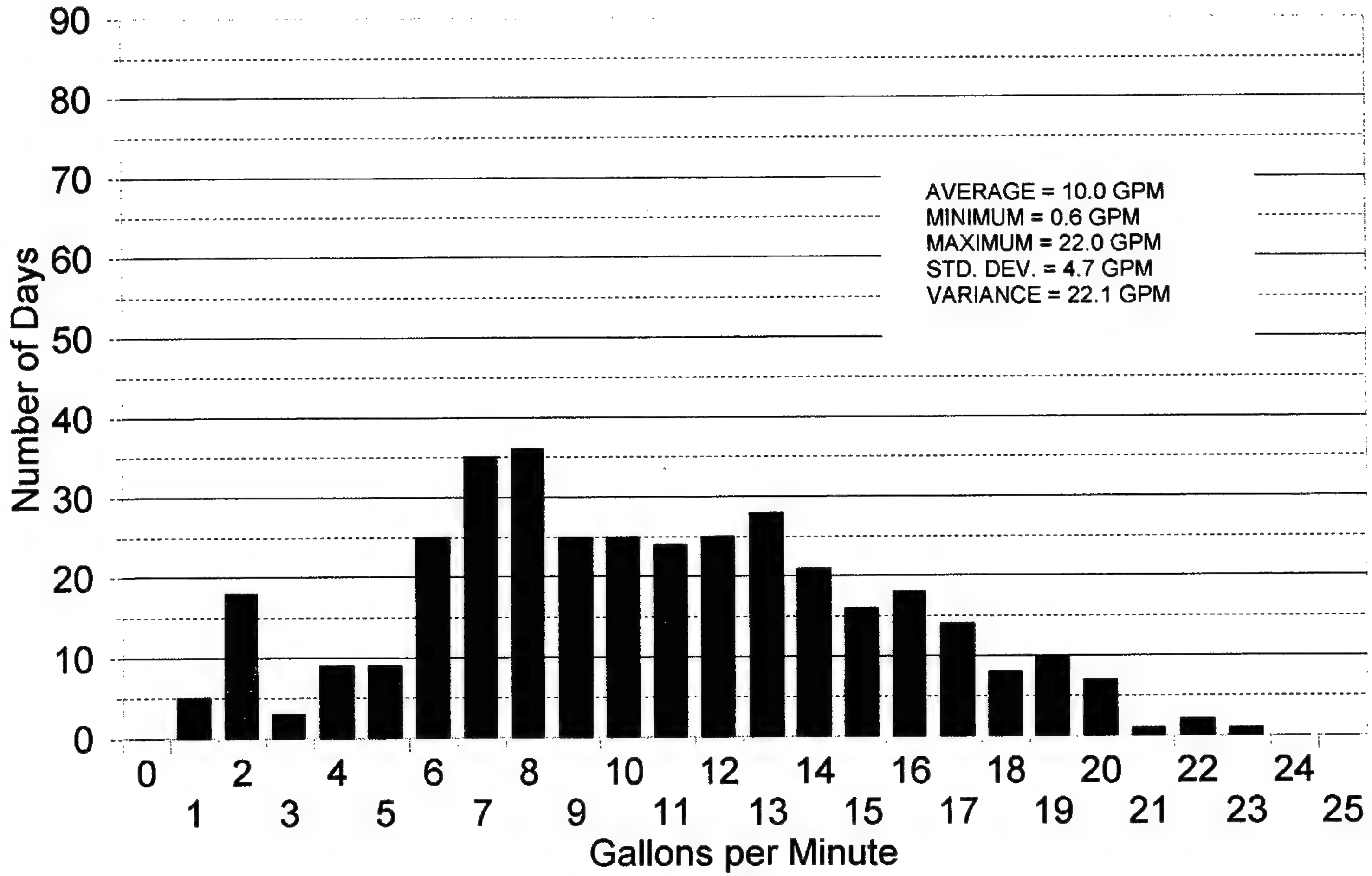
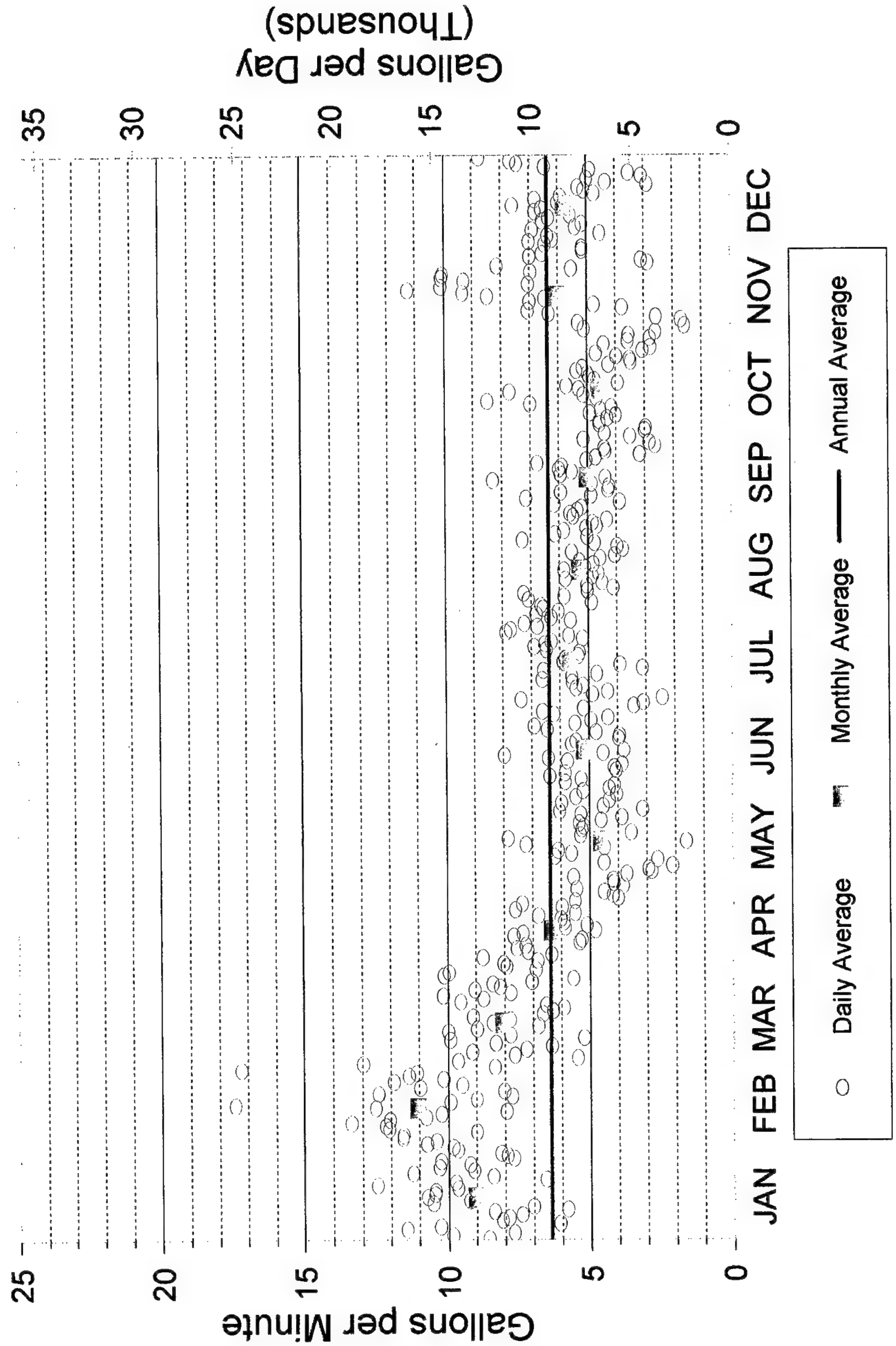


Figure 4.1-5

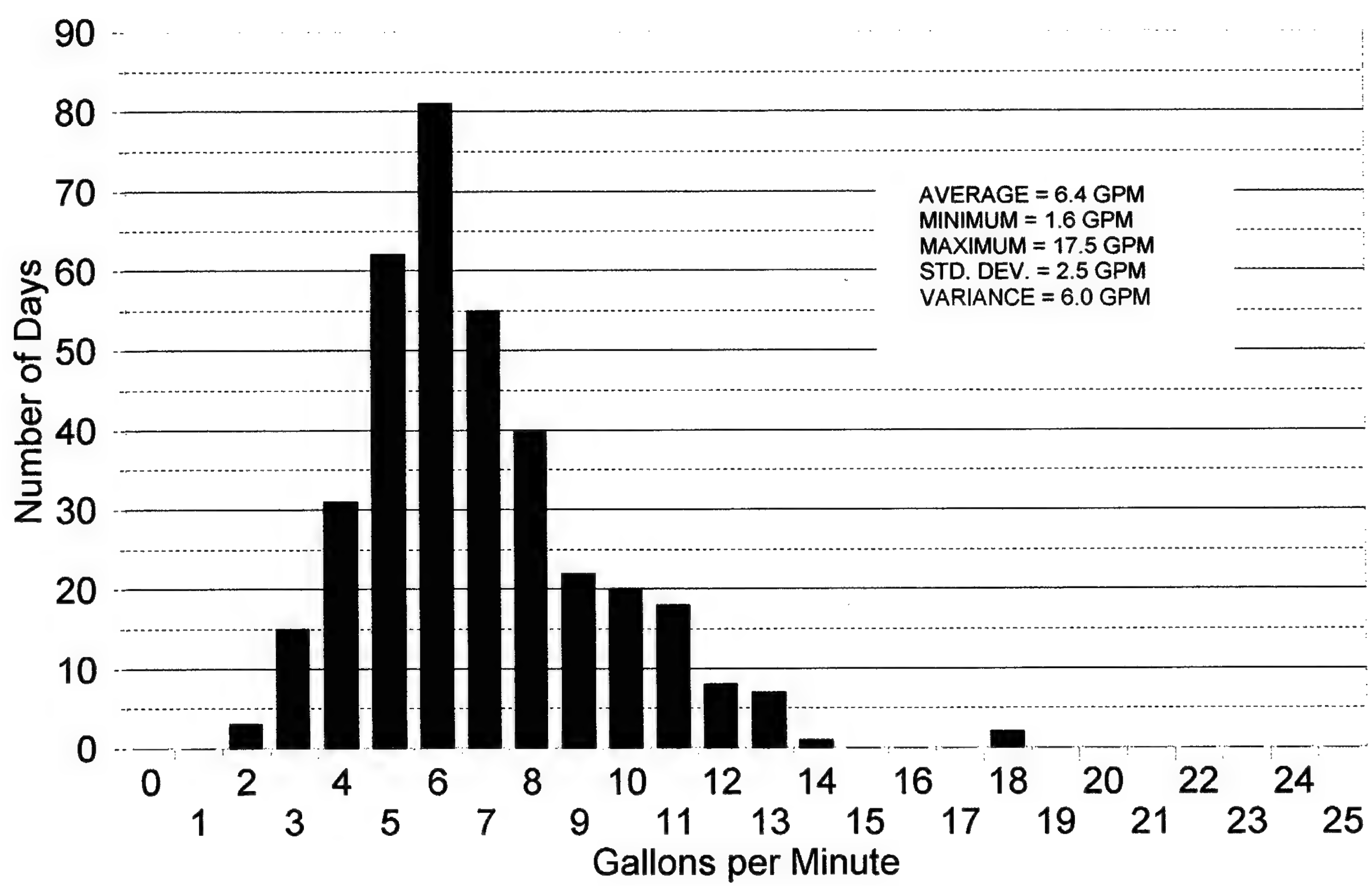
Fort Stewart HTW Make-up Water, 1995




9/96

Figure 4.1-6

## HTW Make-up Water Statistics, 1995



Are these all HTW or are some of them water from the boiler steam drum (top blowdown) and mud drum (bottom blowdown)?

## 4.2 ESTIMATE OF HTW LOSSES

Theoretically, the losses from the HTW distribution system are equal to the HTW make-up water less all known losses due to blowdown, soot blowing, miscellaneous plant leaks, leaks in valve pits and leaks in mechanical equipment rooms. This section describes the estimates of the various known system losses and then uses those estimates to calculate the leaks associated with the underground HTW piping.

There are 12 HTW blowdown points in the CEP and four HTW blowdown points in the SEP. Table 4.2-1 lists all of the blowdown points and shows the estimated amounts of water loss due to each blowdown operation. Different duration estimates were obtained from the boiler operators so water loss values were calculated for winter and summer based on both estimates and then the estimates were averaged. The average estimated water loss due to blowdown is 1.00 GPM or 1,440 GPD.

There are two IK type soot blowers for the wood-fired boiler. These soot blowers are currently operated on a timed basis, two times per shift or six times per day. Steam (water) used by the soot blowing operation is exhausted from the boiler via the stack so it is a system loss. The manufacturer, Diamond Power, estimates that 325 pounds of steam (39 gallons of water) are consumed each time a soot blower is operated. The total daily estimated steam consumption for soot blowing is 3,900 pounds, which is equal to about 470 gallons of water per day (0.33 GPM). Are there no soot blowers for boilers 1,2,3?

During our survey of the CEP, we found a number of small leaks from valve stems, pipe fittings and pump glands. The total estimated losses due to these miscellaneous leaks is approximately 0.21 GPM (300 GPD). The survey of the CEP also indicated a significant amount of steam was continuously venting from the boiler Number 4 blowdown tank. Most of this steam loss is caused by leaking steam traps in the main steam line, the soot blower warm-up line and in the boiler feed pump turbine line. There is also a small amount of water leaking from the rear water wall header blowdown valves.

Make-up water data for October and November of 1995 was used to estimate the amount of losses due to the leaks associated with the Number 4 boiler. The daily make-up water consumption when only boiler Number 4 was operating averaged about 4.86 GPM (7,000 GPD). The daily make-up water consumption with only Units 1, 2 and 3 operating averaged about 4.10 GPM (5,900 GPD). The difference of 0.76 GPM (1,100 GPD) appears reasonable. This reduction in average daily HTW make-up water consumption can be attributed to three principal causes - the leaks associated with boiler Number 4, the miscellaneous leaks found in the CEP and the consumption of steam for soot blowing. By subtraction, the losses due to leaks associated with the Number 4 boiler are 0.76 - 0.21 - 0.33 = 0.22 GPM (320 GPD).

- or?

## Table 4.2-1 ESTIMATED WATER LOSS DUE TO BLOWDOWN

| Blowdown Point | Duration Est. (min) | | Pipe Dia. | Pipe Length | Pres. Drop | Flow | | | Average |
|---|---|---|---|---|---|---|---|---|---|
| | Est. #1 | Est. #2 | (in) | (ft) | (ft) | (gpm) | (gpd, #1) | (gpd, #2) | (gpd) |
| **Intermittent (1)** | | | | | | | | | |
| Heater #1 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #2 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #3 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| No. 4 Boiler | | | | | | | | | |
| East Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| Rear Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| East Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| **Sub-total Intermittent Blowdown - Summer** | | | | | | | 448 | 343 | 395 |
| Heater #4 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #5 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| **Additional Intermittent Blowdown - Winter** | | | | | | | 201 | 83 | 142 |
| **Continuous (2)** | | | | | | | | | |
| Steam Drum | 1440 | 0 | 1/16 | 100 | 400 | 1.353 | 1948 | 0 | 974 |
| **Total Blowdown - Summer** | | | | | | | 2396 | 343 | 1369 |
| **Total Blowdown - Winter** | | | | | | | 2597 | 425 | 1511 |

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

The results of the SEP leak test procedure described in Section 3.2 and the survey of the SEP zone valve pits demonstrated that the SEP HTW distribution system currently has no detectable losses. However, during our survey of the SEP, leaks were found in the east heater gauge glass, the east heater steam stop valve, the west heater equalization valve, the HTWS check valve and the blowdown valves for both heaters. These leaks account for a total HTW loss of approximately 0.23 GPM (340 GPD).

The valve pit survey included a visual inspection of 92 valve pits, valve boxes and drain pits. Based on observed steam flow from the HTW conduit vents, there are 28 sections of HTWS and HTWR piping with possible HTW leaks. The low volume of steam flowing from the conduit vents indicates that there are no significant leaks. There were also 13 valve pits with HTW leaks from valves and fittings. The total estimated HTW losses from leaks in the valve pits are approximately 0.97 GPM (1,400 GPD).

Surveys performed on 127 of the 133 mechanical equipment rooms indicated many HTW leaks from valves, flanges and pipe fittings. The estimated HTW losses are 0.88 GPM (1,260 GPD) from the mechanical equipment rooms. Analysis of the DHW samples indicated approximately 20 hot water generators might have HTW leaks in their heat exchangers. Subsequent tests with a sound diagnostic probe were inconclusive. The results of the DHW sample analysis are contained in Appendix A.6.

Losses from the underground HTW piping are dependent on the pressure in the system. Since the HTW system pressure is fairly constant throughout the year, the losses from the HTW piping should also be fairly constant. Figure 4.1-5 shows an increase in the HTW make-up for January, February and March of 1995. This increase must be due to leaks in the building heating equipment and from the SEP system. These losses were estimated to be about 377,000 gallons over the 3-month heating season. The SEP and heating equipment losses are approximately 0.72 GPM (1,030 GPD) when averaged over the entire year.

The SEP start-up losses for 1995 were calculated from the daily HTW make-up water data. These losses were estimated to be about 58,100 gallons over the 11 day start-up period. The SEP start-up losses are about 0.11 GPM (160 GPD) when averaged over the entire year.

Two HTW leaks were found and repaired in February 1995. The total HTW losses associated with these leaks were calculated from the daily HTW make-up water data. The estimated HTW lost was 20,000 gallons per leak or a total of 40,000 gallons. Losses due to these two major HTW piping leaks that were found and repaired in 1995 are about 0.04 GPM (50 GPD) when averaged over the entire year.

As described in the previous section, the average HTW system make-up water use for 1995 was 6.37 GPM (9,180 GPD) and was considerably lower than the previous two years. The average make-up water use for 1995 will be used to estimate the average annual HTW distribution system losses because it is the most current data and reflects how the entire HTW production and distribution system is operating at this time. Table 4.2-2 lists all of the HTW losses and shows the estimate for the annual average HTW underground piping losses is approximately 1.66 GPM (2,410 GPD).

The results of the CEP leak test procedure described in Section 3.2 yielded a loss of 1,787 gallons in an eight-hour period. This is equivalent to 5,361 gallons per day or 3.72 gallons per minute. This loss estimate includes the leaks found in the CEP, valve pits and mechanical equipment rooms. Subtracting these losses from the test result provides an estimate of the HTW distribution system leaks during the non-heating season: 3.72 - 0.22 - 0.21 - 0.97 - 0.88 = 1.44 GPM (2,070 GPD). This value compares favorably with the 1.66 GPM of HTW losses calculated and shown in Table 4.2-2.

**Table 4.2-2 HTW SYSTEM LOSS ESTIMATES**

| DESCRIPTION OF LOSS | GALLONS/MINUTE | GALLONS/DAY |
|---|---|---|
| Boiler/Cascade Heater Blowdown | 1.00 | 1,440 |
| Soot Blowing | 0.33 | 470 |
| Miscellaneous CEP Leaks | 0.21 | 300 |
| Leaks from Boiler Number 4 Piping | 0.22 | 320 |
| Miscellaneous SEP Leaks | 0.23 | 340 |
| Valve & Fitting Leaks in Valve Pits | 0.97 | 1,400 |
| Mechanical Equip. Room Leaks | 0.88 | 1,260 |
| Heating Equipment and SEP Losses(1) | 0.72 | 1,030 |
| SEP Start-Up Losses(1) | 0.11 | 160 |
| Repaired HTW Piping Leaks(1) | 0.04 | 50 |
| **Subtotal Identified Losses(2)** | 4.71 | 6,770 |
| Average 1995 HTW Make-up Water | 6.37 | 9,180 |
| **Estimated HTW Piping Leaks(3)** | 1.66 | 2,410 |

(1) Losses obtained from the HTW make-up data, could not be visually verified during the survey.

(2) Some leaks may have been repaired or new leaks may have formed since the survey.

(3) Other leaks may include HVAC equipment, hot water generators, equipment repairs, etc.

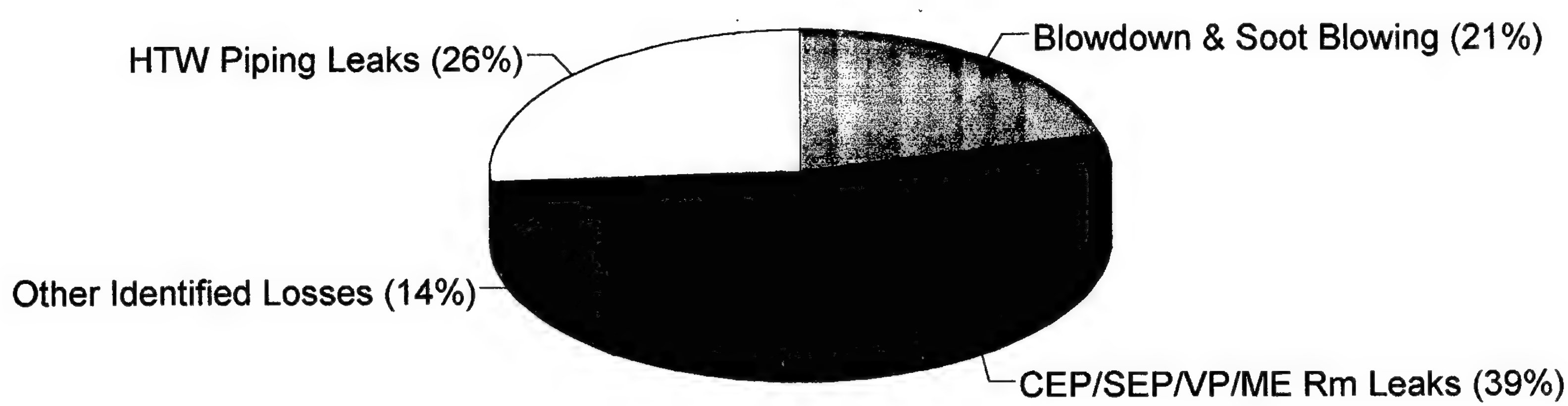
The estimated losses for the HTW piping distribution system are between 1.44 GPM (2,070 GPD) and 1.66 GPM (3,650 GPD). The pie chart in Figure 4.2-1 shows the percentage of total HTW losses that can be attributed to blowdown and soot blowing, miscellaneous valve and fitting leaks, other identified losses and to leaks in the HTW underground piping system. The HTW piping leaks represent about 26 percent of the total HTW losses, however, with a total of only about 1.5 GPM of leaks spread fairly evenly over 28 sections of HTWS and HTWR pipes, the cost of finding and repairing these leaks would be high. The remaining 74 percent of the losses are above ground, accessible and much more cost effective to repair.

The 1995 average make-up water less blowdown and soot blowing is about 7,270 GPD. Based on the total estimated volume of HTWS, steam and HTWR in the HTW production and distribution system of 180,000 gallons, the HTW leakage represents about four percent of the total HTW system volume per day. Typical closed loop distribution systems have a makeup requirement of one-fourth to one-half of one percent of the total system volume in a given 24-hour period. Based on size and operating pressure, the HTW system at Fort Stewart is not a typical system and the current HTW losses can be significantly reduced.

Figure 4.2-2 shows the amount of HTW piping leaks for 1993, 1994 and 1995, assuming the blowdown, soot blowing, and miscellaneous valve/equipment leakage has remained constant over the previous three years. This chart indicates the maintenance staff at Fort Stewart has done a good job of reducing the HTW system losses over the last three years.

Figure 4.2-1

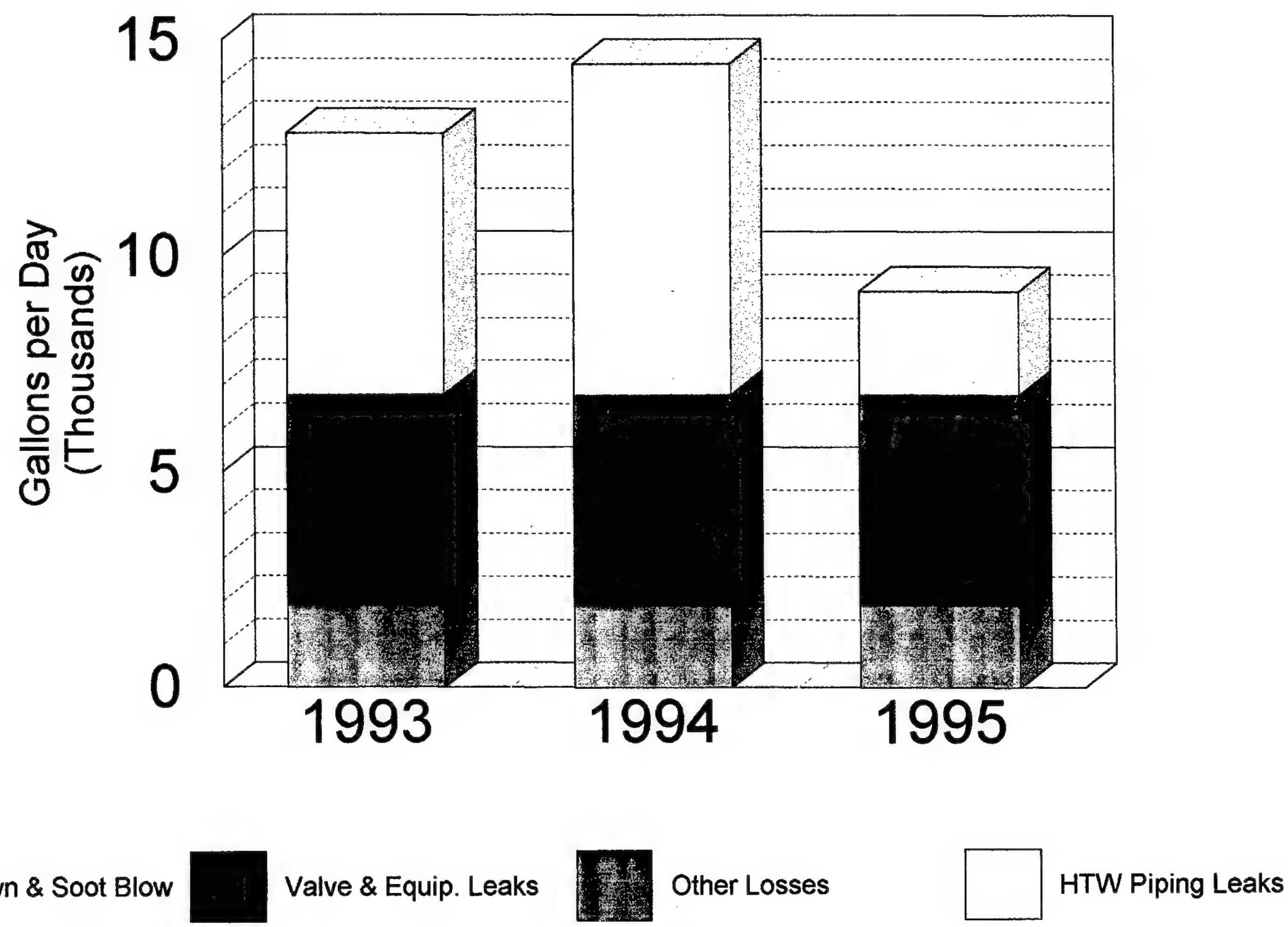
## Fort Stewart HTW Loss Estimates, 1995




ANNUAL AVERAGE HTW SYSTEM MAKE-UP WATER = 6.4 GPM

Figure 4.2-2

Fort Stewart Historical HTW Losses



## 4.3 WATER QUALITY AND TREATMENT

The main types of corrosion that affect piping systems are general corrosion, localized or pitting corrosion, galvanic corrosion and erosion. General corrosion is caused by acidic water conditions and occurs over the entire surface area of the piping. Localized or pitting corrosion is caused by oxygen in the water and tends to attack small areas of the pipes. Pitting is the most serious form of corrosion because it can penetrate the pipe in a short period of time. Galvanic corrosion occurs when different metals come in contact with each other. Erosion is due to suspended solids and high water velocities. The HTW system at Fort Stewart does not use dissimilar metals and the velocity is typically not very high, therefore, it is most susceptible to general corrosion and pitting corrosion.

Chemical characteristics of the HTW that can affect corrosion include oxygen and other dissolved gasses, dissolved solids and alkalinity or acidity (pH). Oxygen dissolved in the water is required for the cathodic reaction to take place. Dissolved solids affect the corrosion reaction by increasing the electrical conductivity of the water. Water that is more alkaline promotes the formation of a protective oxide layer on the surface of the pipe. Acidic and slightly alkaline water can dissolve the metal and the protective oxide film on metal surfaces.

Methods to minimize corrosion include using sacrificial metals for cathodic protection and chemical treatment to control pH and provide a protective film on the metal surfaces. Fort Stewart utilizes chemical treatment to prevent corrosion and scale formation in the HTW system. The chemicals used at the CEP are sodium sulfite, morpholine, and sodium hexametaphosphate.

Oxygen is removed from the HTW by using a deaerator and adding sodium sulfite. Sodium sulfite is an oxygen scavenger. It neutralizes (ties up) residual oxygen by combining with it to form an inert compound. The cathodic reaction requires oxygen. Since the oxygen is removed by the deaerator and sodium sulfite, the use of sacrificial metals at Fort Stewart would be a redundant and unnecessary activity. Morpholine is added at the CEP to control (raise) the pH in the HTW system. Maintaining the water at a high pH and a high causticity controls the general corrosion of the system.

The potential for scale formation is dependent on the amount of scale-forming material (mainly calcium and some magnesium) dissolved in the water and the pH of the water. Fort Stewart uses a water softener to remove calcium and magnesium from the make-up water. The make-up water is also treated with sodium hexametaphosphate which ties up any calcium and magnesium remaining in the HTW system.

Table 4.3-1 lists the results of the boiler and HTW system water analysis for samples taken on July 18, 1995. A copy of the water analysis reports is contained in Appendix A.6. Causticity and pH are high within their control ranges which is good for general corrosion control. The sulfite is very high for Boiler No. 4 and in the middle of the control range for the HTW supply. This means there is adequate oxygen removal and pitting corrosion is controlled. The very high sulfite level for Boiler No. 4 does not adversely affect the HTW system, however, it does indicate excessive amounts of sodium sulfite are being added to the system. This is probably due to utilizing the chemical feed system for the boiler to control the sulfite level in the HTW system. The CEP staff should investigate the possibility of installing separate chemical treatment systems for the boiler and the HTW system.

**Table 4.3-1 CEP Water Analysis for July 1995**

| Property | Control Range | Boiler No. 4 | HTW Supply | HTW Return |
|---|---|---|---|---|
| Phosphate | 30 - 60 | 23 | N.A. | N.A. |
| Sulfite | 20 - 40 | 549 | 30 | N.A. |
| Causticity | 20 - 200 | 120 | N.A. | N.A. |
| Total Diss Solids | 3000 - 3500 | 1400 | N.A. | N.A. |
| Hardness | < 2 | N.A. | < 1 | < 2 |
| pH - HTWS | 9.3 - 9.9 | N.A. | 9.2 | N.A. |
| pH - HTWR | 7.5 - 8.8 | N.A. | N.A. | 8.7 |

The total dissolved solids is mostly sodium which is benign. The value for total dissolved solids is less than half of the low end of the recommended range. Low values are good for corrosion prevention, however, it does not need to be that low. This indicates that boiler blow down is excessive which causes unnecessary losses of water, chemicals and energy. Total dissolved solids is directly related to the quantity of blow down, therefore, the boiler blow down should be reduced by about 50 percent.

The CEP staff indicated the causticity would rise when they reduced the blow down frequency. This may be due to high alkalinity of the make-up water. When blow down is reduced, the alkalinity in the boiler cycles up causing the causticity to rise. If this is the problem, a de-alkalizer (which is similar to a water softener) could be installed to remove the undesirable alkalinity from the make-up water. This problem should be investigated further by the CEP staff and the water analysis contractor.

The phosphate level in the boiler was below the control range. Corrective action should be taken to prevent scale formation. The phosphate level can be increased by reducing blow down or increasing the phosphate dosage. Hardness is a measure of the calcium and magnesium in the water. This value is directly related to scale potential. The hardness measurements for the HTWS and HTWR are both within the control range.

The overall water quality and treatment program at Fort Stewart is good. Implementation of the recommendations described in this section, combined with the current treatment program should provide excellent and efficient corrosion and scale prevention.

## 4.4 EVALUATION OF ENERGY CONSERVATION PROJECTS

The following ECOs were evaluated for their technical and economic feasibility.

ECO-1 Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

ECO-2 Reduce blowdown of the cascade heaters and the wood-fired boiler.

ECO-3 Reduce soot blowing, install an exit gas temperature indicator on the wood-fired boiler.

ECO-4 Repair HTW and steam leaks in the CEP and the SEP.

ECO-5 Repair HTW leaks in the mechanical equipment rooms.

ECO-6 Repair building side DHW and HVAC hot water leaks.

ECO-7 Repair HTW leaks in valve pits, drain pits and valve boxes.

ECO-8 Repair underground HTW distribution system leaks.

ECO-9 Reduce or eliminate HTW discharge during SEP start-up.

- Option A. Improve start-up procedure for the SEP.
- Option B. Install a new condensate/HTW return pump in the SEP.

ECO-10 Use an alternative heating method to reduce SEP operating cost.

- Option A. Distribute HTW from the CEP to the SEP instead of steam.
- Option B. Shut down the SEP and use individual oil-fired boilers in the buildings served by the SEP.

ECO-11 Purchase leak locator equipment or contract leak locator service when a major HTW leak occurs.

ECO-12 Reduce boiler and HTW system operating pressure.

The following pages contain a brief description of each project, a discussion of the analysis performed, results of the life cycle cost analysis and recommendations based on the results. The calculations, cost estimates, Life Cycle Cost Analysis Summary sheets and back-up data are contained in Appendix A.3.

## ECO Number 1

Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

**Description**

This project consists of replacing the existing underground HTW piping system with a new shallow trench distribution system. The existing HTW piping could be demolished and removed or it could be abandoned in place. The cost estimate and economic analysis assumes the existing HTW piping will be removed and sold for scrap. The new HTW piping design calls for Schedule 80 steel pipe with welded joints. The new HTW pipe will be insulated with calcium silicate, installed inside a metal conduit and positioned in a shallow trench.

**Analysis**

This project is specifically called for by the scope of work, however, our surveys and analysis have indicated that the losses due to HTW leaks from the underground distribution system average only about 2.53 GPM which is 1,329,800 gallons per year. These losses are low considering the length and age of the piping system. However, there are substantial heating energy losses due to deteriorated and moist insulation.

Light steam flow and dripping was observed at many of the HTW conduit vent pipes during the valve pit survey. Since the estimated leaks in the HTW system were so low, it was assumed that the steam was being produced by ground water leaking into the HTW conduit. The conductivity of the insulation will increase dramatically with the introduction of moisture. A study of buried pipes for the district heating system at Fort McClellan estimated the heat transfer rates to be 55 Btu/Hr•LF for dry, insulated buried pipes and 275 Btu/Hr•LF for buried pipes with entrapped moisture and deteriorated insulation. The energy savings calculations assume that approximately one-half of the total length of HTW piping at Fort Stewart has deteriorated and moist insulation.

A small amount of energy and water savings are achieved by reducing the HTW losses from 2.53 GPM to approximately 0.10 GPM. The savings calculations and economic analysis assume an average of two leaks in the HTW piping each year and an average HTW loss of 20,000 gallons per leak.

The operation and maintenance savings associated with the need to repair about two HTW leaks per year is included in the economic analysis. The operation and maintenance cost includes trench excavation, HTW pipe repair and backfilling of the trench. Lengths and sizes of HTW piping used for energy savings calculations and cost estimates were taken from drawings titled Fort Stewart Central Heating and Cooling - Existing Conditions.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $24,612,000 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 6.5 |
| Heating Fuels (MBtu/Year) | 177,890 |
| Water (Gallons/Year) | 1,317,240 |
| Annual Energy Cost Savings | $238,460 |
| Annual Water Cost Savings | $730 |
| Annual O&M Cost Savings | $8,120 |
| Savings to Investment Ratio (SIR) | 0.15 |
| Simple Payback (Years) | 100 |

Based on the life cycle cost analysis, this project is not recommended. The construction costs for a new piping system is very high and the relatively small amount of HTW losses from the existing system do not justify a new piping system. The HTW piping is approximately 20 years old, but there are currently very low losses due to leaks in the piping. As the piping system approaches the end of its useful life and more small and large HTW leaks occur, this project should be re-evaluated. An alternative to look at an above ground piping system should also be considered due to the high level of the ground water at Fort Stewart.

## ECO Number 2

Reduce blowdown of the cascade heaters and the wood-fired boiler.

**Description**

Blowing down the boiler is required to control the water chemistry inside the boiler. Insufficient blowdown can severely damage the boiler pressure parts and increase the corrosion rate of the HTW distribution system piping. Excessive blowdown of the boilers and cascade heaters wastes water, chemicals and energy which increases the operating costs of the CEP. The boilers and cascade heaters should be blown down as little as possible, while keeping the boiler water chemistry under control.

The current practice is to blowdown all points once per shift. Typically, the blowdown duration is as short as possible. The valve is opened fully, allowed to blowdown for ten seconds and then closed. As a practical matter, the duration of each blowdown cannot be reduced very much, however, the frequency of blowdown can be reduced. This project involves reducing the frequency of boiler Number 4 and cascade heater blowdown operations currently being used.

**Analysis**

Dissolved and suspended solids accumulate in the boiler water and HTW. These solids originate from a number of sources inside and outside the HTW system. The concentration of these solids must be maintained below a maximum value to assure continued operation of the boiler and cascade heaters. Operators manually open blowdown valves on both the boiler and the cascade heaters to flush away the accumulation of solids. Fresh make-up water, which is relatively free of solids, is pumped into the system to maintain the desired water level.

The American Boiler Manufacturer's Association (ABMA) recommends the following water concentrations for boilers operating below 300 psig - less than 3,500 parts per million (ppm) total dissolved solids, less than 700 ppm alkalinity and less than 300 ppm total suspended solids. Total dissolved solids is directly related to the quantity of blowdown. Three of the boiler water analysis reports (see Appendix A.3) by Puckorius & Associates (P&A) for 1995 list total dissolved solids for boiler Number 4 at 1,800 ppm, 1,750 ppm and 1,400 ppm. These values are well below the recommended parameters, which indicates the boilers are being blown down too much. The P&A reports call for a control range of 3,000 ppm to 3,500 ppm for total dissolved solids and they also recommend that the blowdown be reduced. Having low total dissolved solids does not adversely affect the HTW system. However it means water, chemicals and energy are being wasted.

Blowdown losses were estimated by identifying all system blowdown points, frequencies and durations. The flow from each point was calculated and all of the points summed to obtain an average daily blowdown quantity. The total blowdown losses are estimated to be approximately 1,440 GPD. The boiler water analysis reports indicate that the concentrations of total dissolved solids are about one-half of the recommended value, therefore, the blowdown frequency should be reduced by approximately 50 percent. Reducing the blowdown frequency from every day to every other day would lower the HTW losses to about 720 GPD. There may be some operation and maintenance savings in addition to the energy and water savings, but they were not included in the economic analysis.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $500 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0 |
| Heating Fuels (MBtu/Year) | 1,000 |
| Water (Gallons/Year) | 262,800 |
| Annual Energy Cost Savings | $1,340 |
| Annual Water Cost Savings | $150 |
| Annual O&M Cost Savings | $2,360 |
| Savings to Investment Ratio (SIR) | 114 |
| Simple Payback (Years) | 0.13 |

Based on the life cycle cost analysis, this project is recommended. Finding the right combination of frequency and duration is a trial and error process. Fortunately, the solids concentration in the HTW system will change very slowly. It may take weeks to raise the solids concentration to the desired level. To make this process as easy as possible, boiler operating staff should maintain all of the current blowdown durations but reduce the frequency to every other day. When the solids concentration rises to the desired level, boiler water analysis will indicate if the blowdown duration should be increased or reduced to maintain the proper level.

The CEP staff indicated the causticity would rise when they reduced the blowdown frequency. This may be due to high alkalinity of the make-up water. When blowdown is reduced, the alkalinity in the boiler cycles up causing the causticity to rise. If this is the problem, a dealkalizer (which is similar to a water softener) could be installed to remove the undesirable alkalinity from the make-up water. This problem should be investigated further by the CEP staff and the water analysis contractor.

## ECO Number 3

Reduce soot blowing, install exit gas temperature indicator on the wood-fired boiler.

**Description**

This project consists of installing a simple thermometer in the hot gas duct between the boiler outlet and the air heater. The thermometer will provide an indication of the boiler exit gas temperature. Ideally, the exit gas temperature should be recorded in the control room so the operator can watch the rate at which the boiler is fouling. Operators should record the boiler exit gas temperature every hour and only activate the soot blowers when the exit gas temperature gets above a predetermined value. The boiler exit gas temperature will rise with increasing load so the operators should have a chart showing "clean boiler" exit gas temperature for a range of boiler loads.

The soot blowers should be cycled once when the exit gas temperature is 40 degrees F above the clean boiler temperature for the current boiler load. The exit gas temperature should decrease to the clean boiler value while the soot blowers are operating. The blowers should not be operated again until the boiler exit gas temperature is equal to or greater than 40 degrees F above the clean boiler temperature. When the boiler load is low it may take many hours to foul the tubes enough to warrant soot blowing. Soot blowing may become more frequent at higher loads.

**Analysis**

Some of the solid products of combustion of wood accumulate on the heat absorbing surfaces of the boiler which hinders the heat transfer process. These accumulations are removed by blowing them away with a high pressure (80 psig) steam jet directed at the boiler tubes. Cleaning the tubes allows more heat to be absorbed by the boiler, reducing the boiler exit gas temperature and increasing the boiler efficiency.

The soot blowers from the wood-fired boiler are currently operated on a timed basis, two times per shift or six times per day regardless of need. Steam (water) used by the soot blowing operation is exhausted from the boiler via the stack so it is a system loss. Frequent soot blowing wastes valuable steam energy, particularly at low boiler loads. Blowing soot too often can also cause excessive tube erosion and possibly result in premature tube replacement. Proper soot blowing is the art of keeping boiler efficiency high without wasting steam energy and shortening tube life.

Soot blowing should be initiated primarily based on boiler exit gas temperature. High exit gas temperatures indicate that energy released by the fuel is not being absorbed through the dirty tube surfaces. Typically, a 40 degrees F rise in exit gas temperature is approximately equal to one percent in boiler efficiency. This "rule of

thumb" is often used to determine when the boiler has become fouled with the solid products of combustion and the operation of the soot blowers should be initiated. There is currently no instrumentation that provides an indication of boiler exit gas temperature.

There are two IK type soot blowers for the wood-fired boiler. The manufacturer, Diamond Power, estimates that 325 pounds of steam (39 gallons of water) are consumed each time a soot blower is operated at 80 psig. The total daily estimated steam consumption for soot blowing in the Number 4 boiler is 3,900 pounds, which is equal to about 470 gallons of water per day (0.33 GPM).

Boiler log data shows the air heater exit gas temperature remains nearly constant which means the boiler tubes are probably not fouled enough to cause the temperature to rise. The energy savings calculations and economic analysis assumes the soot blowing frequency can be reduced to one blow per shift. This would reduce the HTW losses due to soot blowing by approximately 50 percent or 235 GPD.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $230 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0 |
| Heating Fuels (MBtu/Year) | 1,226 |
| Water (Gallons/Year) | 85,340 |
| Annual Energy Cost Savings | $1,640 |
| Annual Water Cost Savings | $50 |
| Savings to Investment Ratio (SIR) | 107 |
| Simple Payback (Years) | 0.14 |

Based on the life cycle cost analysis, this project is recommended. The boiler tubes that face the soot blower should be carefully inspected annually. This inspection should include a measurement of the tubes outer diameter with a micrometer to determine the rate of tube metal erosion. It is better to replace a tube that is near the end of its useful life than to have it fail during operation.

## ECO Number 4

Repair HTW and steam leaks in the CEP and the SEP.

**Description**

A number of HTW leaks were discovered during the survey of the CEP and the SEP. The locations were generally at "joints" in the piping system such as flanges, valve packings, valve bonnets and pump seals. This project includes the replacement of some valves and steam traps and tightening the bolts on other various flanges, fittings and valve stems.

**Analysis**

Most of the miscellaneous HTW leaks in the CEP are from the HTW zone pump packing glands. Pumps P-10 and P-11 have significant leaks and Pumps P-4, P-5, P-23 and P-24 have only minor leaks. There are also small leaks from seven of the valves and fittings on the three cascade heaters and the deaerator. Because the pumps have such a high operating pressure, the economic analysis assumes that only about 50 percent of these leaks can be repaired.

The leaks in the CEP associated with Unit Number 4 include two leaking blowdown valves on the rear water wall header, leaking steam traps on the main steam line, soot blower warm-up line and the boiler feed pump turbine line and continuous operation of the atomizing steam when no oil is being burned. The economic analysis assumes that approximately 90 percent of these leaks can be repaired.

Miscellaneous leaks in the SEP consist mainly of leaking blowdown valves on both of the cascade heaters and an HTW supply check valve. There are also very small leaks in the east cascade heater gauge glass and steam stop valve and in the west cascade heater equalization valve. The economic analysis assumes that all of these leaks can be repaired.

The following table shows the current and target leak quantities. The exact locations and leak estimates are located in Appendix A.3.

| Location | Current (gpm) | % Reduction | Proposed (gpm) |
|---|---|---|---|
| Misc. CEP Leaks | 0.207 | 50 | 0.104 |
| Boiler Number 4 | 0.232 | 90 | 0.023 |
| Misc. SEP Leaks | 0.233 | 100 | 0.000 |
| Total | 0.672 | | 0.127 |

## Results and Recommendations

| | |
|---|---|
| Construction Costs | $4,540 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 1.5 |
| Heating Fuels (MBtu/Year) | 1,091 |
| Water (Gallons/Year) | 286,740 |
| Annual Energy Cost Savings | $1,480 |
| Annual Water Cost Savings | $160 |
| Savings to Investment Ratio (SIR) | 5.38 |
| Simple Payback (Years) | 2.8 |

Based on the life cycle cost analysis, this project is recommended. The operators should be aware of and fix the HTW leaks in the CEP and SEP as soon as they are discovered. The atomizing steam line to the Number 4 boiler should be shut off when oil is not being burned. The soot blower line should be shut off between soot blowing operations.

## ECO Number 5

Repair HTW leaks in the mechanical equipment rooms.

**Description**

This project involves tightening the bolts on flanges and valve stems within the mechanical equipment rooms served by the HTW system. There may also be some valves that must be replaced.

**Analysis**

The survey of the mechanical equipment rooms revealed leaking valves and flanges in 42 of the 127 rooms surveyed. There were a total of 36 leaking valves and 14 leaking flanges. The total estimated HTW losses from valves and fittings within the mechanical equipment rooms are 0.88 GPM (1,260 GPD). The energy savings calculations and economic analysis assume that all of the eight major leaks and about 50 percent of the 38 minor leaks can be repaired. Approximately 1,160 GPD of the HTW leaks in the mechanical equipment rooms would be eliminated.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $4,260 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 2.1 |
| Heating Fuels (MBtu/Year) | 1,612 |
| Water (Gallons/Year) | 423,640 |
| Annual Energy Cost Savings | $2,190 |
| Annual Water Cost Savings | $240 |
| Savings to Investment Ratio (SIR) | 8.46 |
| Simple Payback (Years) | 1.8 |

Based on the life cycle cost analysis, this project is recommended. The maintenance staff currently go in the mechanical equipment rooms two times per year, once for the winter-to-summer changeover and once for the summer-to-winter changeover. There should be two more visits scheduled each year to keep these miscellaneous HTW leaks to a minimum. All that is required is a quick look at the mechanical room floor. If there are any wet spots then there is a leak. The maintenance person should carry a wrench to tighten flanges, fittings and valve stems.

## ECO Number 6

Repair building side DHW and HVAC hot water leaks.

**Description**

This project involves tightening connections to valves and fittings on domestic hot water (DHW) and heating hot water (HHW) pipes within the mechanical equipment rooms served by the HTW system. There are also 11 relief valves that are passing water and should be replaced.

**Analysis**

The survey of the mechanical equipment rooms revealed leaking valves and fittings in 26 of the 127 rooms surveyed. There were leaking circulating pumps, leaking relief valves, leaking drain valves and leaking pipe fittings. The total estimated hot water losses from valves and fittings within the mechanical equipment rooms are 1.9 GPM (2,740 GPD). The energy savings calculations assume that all eight of the major leaks and about 50 percent of the 21 minor leaks can be repaired. Approximately 2,620 GPD of the DHW and HHW leaks in the mechanical equipment rooms would be eliminated.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $1,620 |
| Annual Utility Savings | |
| Heating Fuels (MBtu/Year) | 1,111 |
| Water (Gallons/Year) | 956,410 |
| Annual Energy Cost Savings | $1,490 |
| Annual Water Cost Savings | $530 |
| Savings to Investment Ratio (SIR) | 18.5 |
| Simple Payback (Years) | 0.8 |

Based on the life cycle cost analysis, this project is recommended. The maintenance staff currently go in the mechanical equipment rooms two times per year, once for the winter-to-summer changeover and once for the summer-to-winter changeover. There should be two more visits scheduled each year to keep these miscellaneous DHW and HHW leaks to a minimum. All that is required is a quick look at the mechanical room floor. If there are any wet spots then there is a leak. The maintenance person should carry a wrench to tighten flanges, fittings and valve stems.

## ECO Number 7

Repair HTW leaks in valve pits, drain pits and valve boxes.

**Description**

This project involves tightening the bolts on flanges and valve stems within the valve pits throughout the HTW system. There may also be some valves that must be replaced.

**Analysis**

The survey of the valve pits revealed leaking valves and flanges in 13 of the 95 pits surveyed. There were a total of nine leaking valves and five leaking flanges. The total estimated HTW losses from valves and fittings within the valve pits are 0.97 GPM (1,400 GPD). The energy savings calculations assume that all four of the major leaks and about 50 percent of the nine minor leaks can be repaired. Approximately 1,350 GPD of the HTW leaks in the valve pits would be eliminated. The cost estimate assumes that two of the leaking valves will be replaced.

**Results and Recommendations**

| | |
|---|---|
| Construction Costs | $2,780 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 2.4 |
| Heating Fuels (MBtu/Year) | 1,873 |
| Water (Gallons/Year) | 492,230 |
| Annual Energy Cost Savings | $2,540 |
| Annual Water Cost Savings | $270 |
| Savings to Investment Ratio (SIR) | 15.1 |
| Simple Payback (Years) | 1.0 |

Based on the life cycle cost analysis, this project is recommended. There were many valve pits with inoperable sump pumps. In some cases, the water level was up to the HTW pipes. Allowing the pipe insulation to get wet dramatically increases the thermal losses from the system. The sump pumps should be repaired. The exact locations of the inoperable sump pumps can be obtained from the summary sheets or survey forms located in Appendix B.1.

## ECO Number 8

Repair underground HTW distribution system leaks.

**Description**

This project consists of repairing the leaks in the underground HTW distribution system, which includes leak location, trench excavation, pipe welding, trench backfill and compaction.

**Analysis**

The field survey of the valve pits indicated there were 28 sections of underground HTW piping with possible leaks. Based on the very low flow of steam from the conduit vents, there are no substantial leaks in the underground piping.

A leak detection survey of the selected sections of the underground HTW distribution pipes was performed. Microprocessor based leak correlate equipment was used during this survey in an attempt to determine the quantity, size and location of leaks in the underground HTW piping.

The leak detection tests were inclusive. The system noise (flow, boiling ground water, water hammer, etc.) was too high and/or the leaks were too small to obtain a good correlation. Turning off the HTW zones was discussed with the CEP operators and DPW staff, and it was decided that it was not worth turning off the hospital and dining facilities to try and locate less than 2 GPM of HTW leaks over 22 miles of piping.

Energy, water and labor savings calculations, cost estimates and economic analyses for the repair of leaks in the underground HTW piping assumed there was a small leak in each of the 28 sections of pipe identified during the survey of valve pits. Assuming all of the HTW leaks in the underground distribution system were found and repaired, the annual HTW losses would be reduced by approximately 1.6 GPM or 872,500 gallons per year. The total estimated utility cost savings would be about $4,990 per year.

## Results and Recommendations

| | |
|---|---|
| Construction Costs | $127,870 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 4.3 |
| Heating Fuels (MBtu/Year) | 3,319 |
| Water (Gallons/Year) | 872,500 |
| Annual Energy Cost Savings | $4,510 |
| Annual Water Cost Savings | $480 |
| Savings to Investment Ratio (SIR) | 0.6 |
| Simple Payback (Years) | 25.6 |

Based on the life cycle cost analysis, this project is not recommended. The cost of finding and repairing the leaks is too high compared to the small amount of HTW currently leaking from the underground piping.

## ECO Number 9

Reduce or eliminate HTW discharge during SEP start-up.

**Discussion**

The SEP operates only during the heating season. During start-up, high cascade heater levels are caused by an accumulation of condensed steam with no way to pump it back to the CEP. The current practice is to discharge the excess water at the SEP until the HTW temperature and pressure rise sufficiently to overcome the CEP cascade heater pressure.

Starting up the SEP at the beginning of the heating season results in an estimated loss of about 58,100 gallons of condensate and HTW. Two options were considered to eliminate the discharge of HTW and condensate during SEP start-up. A description and analysis of each option follows.

**Option A. Improve Start-up Procedure for the SEP**

**Description - Option A**

Changing the start-up procedures can eliminate all of the HTW dumping and reduce the labor effort required to operate the SEP. This project option calls for adopting the following procedure to start-up the SEP:

Is there a condensate return line from the SEP back to [illegible] sized for [illegible] load?

1. Warm the main steam line.
2. Fully close the HTW return (inlet) valves at the cascade heaters.
3. Admit full steam pressure to the cascade heaters (the entire circulation system should now be at or near full steam pressure)
4. Start a circulation pump.
5. Slowly crack open both of the HTW return valves at the heaters until a 20 psig reduction in heater pressure is attained. The system pressure should be about 20 psig below steam pressure or about 150 psig.
6. As the water level rises in the heaters, start the HTW return pumps as necessary to maintain the heater levels within operating range. The return pump suction pressure should be sufficiently high when added to the pump head to overcome the line loss and static head at the CEP.
7. As the system temperature rises so also will the pressure in the heater. Continue to slowly open the HTW return valves at the heaters to keep the pressure at 150 psig. As the HTW nears normal operating temperature the HTW return valves may be fully opened. The SEP should now be fully operational.

**Analysis - Option A**

At start-up, the entire SEP system is at ambient temperature. Circulation through the SEP HTW distribution system and the cascade heaters is established after the steam line from the CEP is warmed and ready for service. Steam is then admitted to the cascade heaters to begin warming the cold water. The HTW, which is still cold, is circulating at or near its full load circulation rate to allow the entire system to warm-up at an even rate. When the steam and water mix in the cascade heater, the quantity of cold water is so high relative to the steam available that the steam instantaneously condenses giving up its heat and volume to the cold water. Even with the steam valve wide open, the steam is condensed so quickly that the pressure in the system remains low for some time.

The pressure rises in the SEP as the water temperature rises and is equal to the saturation pressure for the temperature of the water in the SEP cascade heaters. The water level in the cascade heaters begins to rise due to the expansion of the heated water and the increased inventory from the condensed steam. The SEP return pumps do not have enough head to pump the excess water back through approximately one mile of pipe and also overcome the 200 psig pressure in the CEP cascade heaters. The cascade heaters get to their operating level before the pressure rises high enough to help push the excess water back to the CEP and it must, therefore, be thrown out.

**Option B. Install a New Condensate/HTW Return Pump in the SEP**

**Description - Option B**

The condensate must be discharged during start-up because there is insufficient pump head available to pump it back to the CEP and overcome the 200 psig static head at the CEP cascade heaters. Once the SEP reaches normal operating temperature, there is sufficient head to return the condensate to the CEP. This option consists of installing a new pump, piping and controls at the SEP that would return the condensate and HTW during the SEP start-up process.

**Analysis - Option B**

The pump would be installed in the SEP and utilize the existing four-inch return pipe to get the water back to the CEP. The pump was sized based on the maximum possible heating demand for the five buildings on the SEP zone. The pump capacity is about 60 GPM and the total head is approximately 300 feet. The brake horsepower required dictates the selection of a 7.5 horsepower motor. The pump will only operate during start-up of the SEP.

**Energy and Economic Analysis**

The annual energy and water losses and cost were calculated by taking the total make-up water for the 11-day startup period during November 13-23, 1995 and subtracting the average make-up water use for the previous

six months. An average temperature difference was used for the heating energy calculations since the HTW being discharged at the beginning of the start-up process is at the same temperature as the make-up water. There is also a significant amount of labor effort that must be invested each year while the SEP start-up is in progress.

**Results and Recommendations**

| | OPTION A | OPTION B |
|---|---|---|
| Construction Costs | $0 | $32,090 |
| Annual Utility Savings | | |
| Electricity (MBtu/Year) | 0.3 | 0 |
| Heating Fuels (MBtu/Year) | 111 | 111 |
| Water (Gallons/Year) | 58,090 | 58,090 |
| Annual Energy Cost Savings | $150 | $150 |
| Annual Water Cost Savings | $30 | $30 |
| Annual O&M Cost Savings | $1,030 | $9,000 |
| Savings to Investment Ratio (SIR) | N/A | 4.26 |
| Simple Payback (Years) | N/A | 3.5 |

Based on the total net discounted savings shown on the life cycle cost analysis, ECO-9 Option B provides more savings over the life of the project. Analysis of ECO-10 showed that ECO-10 Option A provides the same savings on heating fuels and water and even more savings on electricity and O&M costs than ECO-9 Option B. The life cycle cost analysis for ECO-10 Option A indicates that it offers more total savings, a shorter payback period and a higher SIR than ECO-9 Option B. Therefore, ECO-9 Option B is not recommended. If ECO-10 Option A is not implemented, the plant operators should try the modified start-up procedure described in ECO-9 Option A.

## ECO Number 10

Use an alternative heating method to reduce SEP operating cost.

**Discussion**

There are only five buildings currently served by the SEP. The SEP was built with the idea that the surrounding area would be developed and many new buildings would be added to the SEP zone. It takes a substantial amount of labor effort to start-up and operate the SEP and the system thermal losses are high compared to the relatively low end user heating loads.

Two options were considered to reduce the operational labor and thermal losses associated with the SEP. A description and analysis of each option follows.

**Option A. Distribute HTW to the SEP Instead of Steam**

**Description - Option A**

This project option involves the installation of piping and connections to the CEP as required to supply the SEP with HTW from the CEP. The two phase fluid operation would be eliminated and a significant savings in operation and maintenance costs would result.

**Analysis- Option A**

A major difficulty in operating and maintaining the SEP during the heating season arises from its two phase fluid operation. Current operational problems include assuring proper warm-up of the steam supply line, conserving the resulting condensate, properly warming-up and operating the SEP equipment and its distribution system and maintaining the proper water level in the SEP cascade heaters. Without any automatic controls, this a challenging effort requiring constant visits by operators.

HTW from the CEP can be sent directly to the SEP without any piping revisions outside the CEP. The SEP steam line would be separated from the CEP steam header and blanking plates installed. A four- inch diameter line would be installed connecting the CEP cascade heater discharge header to the SEP "steam" supply line. HTW would then flow directly from the CEP to the SEP. The SEP could be configured, through use of existing valves, to accept HTW, circulate it through its existing distribution system and pump it back to the CEP cascade heaters.

Steam trap isolation valves for the condensate drain system servicing the CEP to SEP "steam" line should be cracked open to protect the condensate line from freezing.

The HTW return valves at the SEP cascade heaters will be closed and the HTW return pumps at the SEP will operate continuously. With the HTW return valves at the cascade heaters closed, there will be enough head pressure to circulate the necessary water between the CEP and the SEP because the circulating pumps and the return pumps will be operating in tandem.

This operating configuration may not be satisfactory if the heating load on the SEP is substantially increased due to the addition of processes or buildings. Should the SEP heating load increase in the future, this operating technique will have to be reassessed. Changing back to steam operation sometime in the future would simply require the removal of the blanking plates from the steam lines, and the installation of new blanking plates in the HTW line at the CEP.

There would be no change in thermal losses from the distribution system because there would be no change in system operating temperature. However, the SEP condensate dumping during start-up would be eliminated and there would be a reduction in start up and operating labor for the SEP.

**Option B. Shut Down the SEP and Install Individual Boilers**

**Description - Option B**

This project option consists of shutting down the SEP and installing new oil-fired heating equipment at each of the SEP supplied buildings. The heating equipment at each building would include an oil-fired hot water boiler, a circulating pump, expansion tank, oil piping system, oil storage equipment and an above ground oil storage tank. The heating equipment would be installed on a concrete slab and enclosed in a small weather proof building.

**Analysis - Option B**

The SEP distribution system operates during the heating months even when there is no demand for heating. The SEP HTW distribution systems remain hot for the entire heating season which allows a significant amount of thermal losses. Approximately 4,680 MBtu/Year is lost by conduction heat transfer from the HTW and steam distribution systems for the SEP. These thermal losses would be eliminated by installing individual boilers. The current operational labor required to maintain the SEP will also be eliminated by this option.

Firing the individual fuel oil boilers would be necessary only when the local building demand required it. Estimates of annual heating season energy consumption were made for each of the five buildings using bin temperature data. The results are shown in the following table and the calculations are contained in Appendix A.3.

| ESTIMATED BUILDING LOADS AND ENERGY USE | | | | | | |
|---|---|---|---|---|---|---|
| Building Number | 4502 | 4577 | 4578 | 4528 | 3002 | Total |
| New Boiler Capacity (MBtu/Hr) | 2.4 | 2.4 | 1.2 | 0.8 | 0.4 | 7.2 |
| Estimated Annual Energy Consumption (MBtu) | 2,458 | 2,458 | 1,229 | 799 | 430 | 7,374 |

Annual energy consumption at each of the buildings will not change, however, the annual energy cost will increase due to the higher cost of fuel oil ($4.40/MBtu) compared to the average cost of the CEP heating fuels ($1.34/MBtu).

**Results and Recommendations**

| | OPTION A | OPTION B |
|---|---|---|
| Construction Costs | $6,770 | $374,340 |
| Annual Utility Savings (Increase) | | |
| Electricity (MBtu/Year) | 0.3 | (0.4) |
| Heating Fuels (MBtu/Year) | 111 | 24,711 |
| Fuel Oil (MBtu/Year) | 0 | (9,218) |
| Water (Gallons/Year) | 58,090 | 58,090 |
| Annual Energy Cost Savings | $150 | ($7,450) |
| Annual Water Cost Savings | $30 | $30 |
| Annual O&M Cost Savings | $10,070 | $12,650 |
| Savings to Investment Ratio (SIR) | 22.5 | (0.19) |
| Simple Payback (Years) | 0.7 | 72 |

Based on the life cycle cost analysis, Option A is recommended. The HTW jumper line in the CEP should be installed during the non-heating season. Operators should practice starting up the SEP on HTW before the following heating season begins. If this option is not implemented, the plant operators should try the modified start-up procedure described in ECO-9 Option A.

## ECO Number 11

Purchase leak locator equipment or contract leak locator service when a major HTW leak occurs.

**Description**

This project involves purchasing leak locator equipment or contracting with leak locator service to find HTW leaks so they can be repaired in a timely manner.

**Analysis**

When a HTW leak occurs in the underground piping, steam and HTW flow forcibly from the conduit vents on both sides of the leak. To repair the leak, the maintenance staff isolates the section of pipe between valve pits and then they begin digging near the valve pit that is showing the most steam flow. This trial and error method can and usually does take numerous attempts before the leak is found. The maintenance staff expressed an interest in purchasing leak locating equipment but they did not know who manufactured this type of apparatus.

The leak location equipment includes two acoustical leak detectors that amplify the audio signals of the leaks and a microprocessor based leak locator. Each leak detector has a radio transmitter with a unique sound channel. Contact is established between the leak detector transducers and the HTW valves at two valve pits that flank a suspected leak. The radio transmitters send audio signals to the microprocessor based leak locator that is situated between the two valve pits.

Distribution information including pipe size, type and measured distance of pipe between the two valve pits are entered into the leak locator. Initialize the leak locator and the leak signals are processed by the computer. Leak position is shown and evaluated on a video display. The exact location of the leak and the distance from the valve pits to the leak are calculated. The amount of HTW escaping from each leak can be estimated by the audible signal of the leak detectors. The distance from the valve pit to the leak is then measured off and the location of the leak is marked.

The energy and labor cost savings analysis assumes a major HTW leak occurs about two times per year and the maintenance staff must dig up approximately 50 cubic yards in each of three different locations between the valve pits to find the leak. The analysis also assumes it will take four hours to find the leak with the leak detection equipment and that it will locate the leak within plus or minus ten feet (approximately 20 feet of trench digging required).

The most recent HTW leaks occurred in early 1995. Make-up water use during these two leaks averaged about 25,000 GPD. Subtracting the 10,000 GPD average make-up water use for 1995 gives an estimate of 15,000 GPD per HTW leak.

**Results and Recommendations**

| | |
|---|---|
| Equipment and Training Costs | $55,500 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0.1 |
| Heating Fuels (Mbtu/Year) | 76 |
| Water (Gallons/Year) | 19,820 |
| Annual Energy Cost Savings | $100 |
| Annual Water Cost Savings | $10 |
| Annual O&M Cost Savings | $5,650 |
| Savings to Investment Ratio (SIR) | 1.5 |
| Simple Payback (Years) | 9.6 |

Based on the life cycle cost analysis, this project is recommended. The economics are marginal; however, if more than two leaks per year occur, the project economics will improve. This equipment can also be used to locate leaks in underground potable water and chilled water pipes.

## ECO Number 12

Reduce boiler and HTW system operating pressure.

**Discussion**

When the No. 4 boiler was initially installed, the system was operated at approximately 225 psig. This might be because the boiler was designed for that pressure and performance guarantees made by the manufacturer required design operating conditions to demonstrate contractual compliance. Soon after start-up, it was determined that the circulating pump seals were failing too frequently. To increase the seal life, the operating pressure on the entire system was reduced to its current level. The boilers and HTW system are currently operated at about 180 psig and the corresponding saturation temperature of 380 degrees F.

During the non-heating season, the energy requirement on the system is rather low. Unit No. 4 carries the whole load which rarely exceeds 50 percent boiler capacity. Heating requirements during this time are limited to domestic hot water in the barracks and dining facilities and autoclave operation at the hospital. Pressure requirements are limited to soot blowing on the No. 4 boiler where the blower set pressure is 80 psig.

A study of underground piping heat losses completed at Ft. McClellan, Alabama showed a heat transfer rate of 55 Btu/Hr-LF for pipes with dry insulation. Pipes with deteriorated and moist insulation had a heat transfer rate of about 275 Btu/Hr-LF. These heat transfer rates were applied to the Fort Stewart HTW piping. The heat loss calculations assumed approximately one-half of the pipes have deteriorated and/or moist insulation. This assumption was based on observations of the pipes in the valve pits and steam flow from the conduit vents. It was also assumed that the heat transfer losses are proportional to the temperature difference between the fluid and the surrounding soil. The calculations yielded a current annual HTW distribution system heat loss of about 160,000 MBtu which required a heating fuel input of about 235,300 MBtu/Year.

Reducing the boiler and HTW system operating pressure and temperature will reduce the heat losses from the system to the surroundings. Operating at lower pressures will result in less stress on the system components; however, the O&M savings would be impossible to estimate with any confidence. Therefore, O&M savings are not included in the economic analysis. Three options were analyzed for reducing the operating pressure to 100 psig, 60 psig and 30 psig. A description and analysis of each option follows.

**Option A: Reduce Boiler and HTW System Pressure to 100 psig.**

**Description - Option A**

All that is necessary to accomplish this option is to slowly reduce the CEP plant master pressure controller from 180 psig to 100 psig.

**Analysis - Option A**

Steam is currently produced at a pressure of about 180 psig which heats the HTW to 380 degrees F. Reducing the operating pressure to 100 psig would reduce the operating temperature to 338 degrees F and the heat transfer losses from the HTW distribution piping to the surroundings would be reduced by approximately 20,566 MBtu/Year. Assuming a boiler efficiency of 68 percent results in a heating fuel savings of 30,244 MBtu/Year.

**Option B: Reduce Boiler and HTW System Pressure to 60 psig.**

**Description - Option B**

This option consists of installing an adjustable steam pressure reducing station between the No. 4 boiler and the main steam header, operating the boiler at 100 psig and operating the HTW system at 60 psig.

**Analysis - Option B**

The highest temperature requirement on the Fort Stewart HTW system are the autoclaves in the hospital. Autoclaves are used for sterilizing surgical instruments. They operate between 280 degrees F and 325 degrees F which requires 35 psig to 80 psig steam, respectively. The No. 4 boiler has to operate at 100 psig to produce its own soot blowing steam. The pressure in the rest of the system can be lowered to 60 psig and still satisfy the heating demands of the rest of the post including the hospital. Reducing the HTW system pressure from 180 psig (380 degrees F) to 60 psig (307 degrees F) would result in a heating fuel energy savings of about 53,115 MBtu/Year.

**Option C: Reduce Boiler and HTW System Pressure to 30 psig.**

**Description - Option C**

This option consists of installing an adjustable steam pressure reducing station between the No. 4 boiler and the main steam header, operating the boiler at 100 psig and operating the HTW system at 30 psig.

**Analysis - Option C**

If Option B is chosen then the entire HTW distribution system is operating at a pressure and temperature just to satisfy the autoclaves. The maximum estimated load for the autoclaves is approximately 5,000 pounds of steam per hour. If the hospital's sterilizing needs were met with a dedicated system, then the HTW system pressure could be reduced to 30 psig. The existing heating and cooling plant at the hospital is only utilized when the CEP is not operational. The boilers in the hospital plant could be operated at 60 psig to serve the autoclaves.

The next highest temperature demand is for the steam generators in the dining facilities. They produce steam at about 15 psig. There are no boilers at the dining facilities, so their steam generator requirements represent the practical lower limit for the HTW system operating pressure. Reducing the HTW system pressure to 30 psig

would provide a 24 degree F temperature difference which should be enough to produce 15 psig steam in the dining facilities.

Calculations show reducing the HTW operating pressure from 180 psig to 30 psig would reduce the heat transfer losses by about 52,671 MBtu/Year and provide a heating fuel energy savings of 77,457 MBtu/Year. The fuel-oil energy required to operate the hospital boiler will be increased by about 26,100 MBtu/Year, but the CEP heating fuel use will be reduced by an additional 32,625 MBtu/Year.

**Results and Recommendations**

| | OPTION A | OPTION B | OPTION C |
|---|---|---|---|
| Construction Costs | $0 | $29,860 | $29,860 |
| Annual Utility Savings (Increase) | | | |
| Electricity (MBtu/Year) | 0 | 0 | 0 |
| Heating Fuels (MBtu/Year) | 30,244 | 53,115 | 110,080 |
| Fuel Oil (MBtu/Year) | 0 | 0 | (26,100) |
| Water (Gallons/Year) | 0 | 0 | 0 |
| Annual Energy Cost Savings | $40,530 | $71,170 | $32,670 |
| Annual O & M Cost Savings (Increase) | 0 | 0 | (24,600) |
| Savings to Investment Ratio (SIR) | N/A | 35.5 | -10.2 |
| Simple Payback (Years) | N/A | 0.4 | 3.7 |

Based on the energy savings calculations, Option A should be implemented and the operating pressure of the CEP and the HTW should be reduced to 100 psig immediately. No capital cost is required to make this change. All that is necessary is to slowly reduce the CEP plant master pressure controller from 180 psig to 100 psig.

Based on the life cycle cost analysis, Option B should be implemented when funding becomes available. Install an adjustable steam pressure reducing station and operate the HTW system at 60 psig. If the end use systems cannot maintain the desired temperatures during the winter months, the pressure can be adjusted up until all requirements are satisfied.

The CEP operators expressed concern that this would add more controls that will possibly fail in the future. They are correct because any control system is subject to failure over time. However, the steam pressure

control station can be installed such that the CEP can be returned to normal operation if the controls require maintenance.

When a boiler is being considered for operation below its design operating pressure, the possible reduction of boiler capacity should also be considered. This is theoretically true for all boilers, however, its practical significance applies when the change in operating pressure is very high. High pressure boilers are usually designed with smaller diameter tubes for structural, thermodynamic and economic reasons. At normal design pressures a bubble of steam formed in the tube would occupy a certain portion of the tube's diameter. At lower pressures the same bubble would occupy a greater portion of the tube cross section. As the firing rate increases to full load, the bubble might take up the entire tube diameter. This condition could interrupt circulation of the cooling water through the tube, cause insufficient cooling of the tube wall and possibly result in tube failure.

The increase in specific volume of the steam could also cause an increase the velocity of the steam passing through the steam drum internals. The steam drum internals, which are designed to separate the water droplets from the steam, might show a reduction in performance due to the increased velocity. The velocity increase for a given load is equal to the ratio of the specific volumes for the two pressures under consideration. Low pressure boilers have larger diameter tubes and the heat releases are lower. The result is low pressure boilers are much less susceptible to the negative effects of reduced pressure operation.

The Fort Stewart boilers do not operate near full load. Typically, when the boiler load gets above 85% an additional boiler is brought into service to keep the load on any one boiler in the "comfortable" range. Therefore, the conclusion is that operating the wood fired boiler at 100 psig and the package boilers at 60 psig should not cause any boiler problems. The following table lists the pros and cons for operating at reduced pressures.

| Boiler Operation Below Design Pressures | | |
|---|---|---|
| Pressure | PROS | CONS |
| 60 psig | • Increased boiler efficiency.<br>• Reduced thermal losses from HTW distribution system.<br>• Increased life of pump seals.<br>• Reduced occurrence of HTW leaks from valves and fittings.<br>• Reduced flow rates from existing HTW system leaks.<br>• No condensate dumping required during SEP startup. | • May require re-calibration of steam flow meters.<br>• Requires installation of 100 psi to 60 psi pressure reducing station .<br>• May cause interruption of boiler circulation.<br>• Pressure may have to be increased during the heating season. |
| 30 psig | • Same as above | • This project is not recommended.<br>• May require re-calibration of steam flow meters.<br>• Requires installation of steam pressure reducing station.<br>• Requires alternate energy source for hospital autoclaves. |

# 5.0 RESULTS AND RECOMMENDATIONS

## 5.1 SUMMARY OF ECO EVALUATIONS

Table 5.1-1 provides a summary of the 12 ECOs and their options that were analyzed for this study.

**Table 5.1-1 SUMMARY OF ALL ECO'S**

| ECO No. | Description | Project Cost $x1000 | SIR | Simple Payback Years | Utility Savings (Increase) Electric MBtu/Yr | Htg. Fuels MBtu/Yr | Fuel Oil MBtu/Yr | Water kGal/Yr | Cost Savings (Increase) Energy $/Year | Water $/Year | O&M $/Year | Total $/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | New HTW Piping | $24,612 | 0.2 | 99.5 | 6.5 | 177,890 | 0 | 1,317 | $238,460 | $730 | $8,120 | $247,310 |
| 2 | Reduce Blowdown | $0.50 | 114.4 | 0.1 | 0.0 | 1,000 | 0 | 263 | $1,340 | $150 | $2,360 | $3,850 |
| 3 | Reduce Soot Blow. | $0.23 | 107.5 | 0.1 | 0.0 | 1,226 | 0 | 85 | $1,640 | $50 | $0 | $1,690 |
| 4 | Fix Plant Leaks | $4.54 | 5.4 | 2.8 | 1.5 | 1,091 | 0 | 287 | $1,480 | $160 | $0 | $1,640 |
| 5 | Fix Mech Rm Leaks | $4.26 | 8.5 | 1.8 | 2.1 | 1,612 | 0 | 424 | $2,190 | $240 | $0 | $2,430 |
| 6 | Fix HW Leaks | $1.62 | 18.5 | 0.8 | 0.0 | 1,111 | 0 | 956 | $1,490 | $530 | $0 | $2,020 |
| 7 | Fix Valve Pit leaks | $2.78 | 15.1 | 1.0 | 2.4 | 1,873 | 0 | 492 | $2,540 | $270 | $0 | $2,810 |
| 8 | Fix HTW Pipe Leaks | $127.87 | 0.6 | 25.6 | 4.3 | 3,319 | 0 | 872 | $4,510 | $480 | $0 | $4,990 |
| 9A | SEP Start-up | $0.00 | 1000+ | 0.0 | 0.3 | 111 | 0 | 58 | $150 | $30 | $1,030 | $1,210 |
| 9B | HTW Return Pump | $32.09 | 4.3 | 3.5 | 0.0 | 111 | 0 | 58 | $150 | $30 | $9,000 | $9,180 |
| 10A | HTW to SEP | $6.77 | 22.5 | 0.7 | 0.3 | 111 | 0 | 58 | $150 | $30 | $10,070 | $10,250 |
| 10B | Shut Down SEP | $374.34 | (0.2) | 71.7 | (0.4) | 24,711 | (9,218) | 58 | ($7,450) | $30 | $12,650 | $5,230 |
| 11 | Leak Locator | $55.50 | 1.5 | 9.6 | 0.1 | 76 | 0 | 20 | $100 | $10 | $5,650 | $5,760 |
| 12A | Oper. at 100 psig | $0.00 | 1000+ | 0.0 | 0.0 | 30,244 | 0 | 0 | $40,530 | $0 | $0 | $40,530 |
| 12B | Oper. at 60 psig | $29.86 | 35.5 | 0.4 | 0.0 | 53,115 | 0 | 0 | $71,170 | $0 | $0 | $71,170 |
| 12C | Oper. at 30 psig | $29.86 | -10.2 | 3.7 | 0.0 | 110,080 | (26,100) | 0 | $32,670 | $0 | ($24,600) | $8,070 |

Table 5.1-2 lists the summary information for all of the recommended ECOs. These ECOs were recommended based on the results of the life cycle cost analyses and are listed in order of descending SIR. All of these ECOs have SIRs greater than 1.5 and simple pay backs of less than ten years. ECO-9 Option A and ECO-12 Option A have also been included in the O&M Recommendations in Section 5.2 because they require no capital expenditure. Energy savings for the recommended ECOs are not additive as shown in Table 5.1-2 because the savings for some ECOs are affected by the implementation of others.

| Table 5.1-2 SUMMARY OF RECOMMENDED ECO'S | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Project | | Simple | Utility Savings (Increase) | | | | Cost Savings (Increase) | | | |
| ECO No. | Description | Cost $x1000 | SIR | Payback Years | Electric MBtu/Yr | Htg. Fuels MBtu/Yr | Fuel Oil MBtu/Yr | Water kGal/Yr | Energy $/Year | Water $/Year | O&M $/Year | Total $/Year |
| 9A | SEP Start-up | $0.00 | 1000+ | 0.0 | 0.3 | 111 | 0 | 58 | $150 | $30 | $1,030 | $1,210 |
| 12A | Oper. at 100 psig | $0.00 | 1000+ | 0.0 | 0.0 | 30,244 | 0 | 0 | $40,530 | $0 | $0 | $40,530 |
| 2 | Reduce Blowdown | $0.50 | 114.4 | 0.1 | 0.0 | 1,000 | 0 | 263 | $1,340 | $150 | $2,360 | $3,850 |
| 3 | Reduce Soot Blow. | $0.23 | 107.5 | 0.1 | 0.0 | 1,226 | 0 | 85 | $1,640 | $50 | $0 | $1,690 |
| 12B | Oper. at 60 psig | $29.86 | 35.5 | 0.4 | 0.0 | 53,115 | 0 | 0 | $71,170 | $0 | $0 | $71,170 |
| 10A | HTW to SEP | $6.77 | 22.5 | 0.7 | 0.3 | 111 | 0 | 58 | $150 | $30 | $10,070 | $10,250 |
| 6 | Fix HW Leaks | $1.62 | 18.5 | 0.8 | 0.0 | 1,111 | 0 | 956 | $1,490 | $530 | $0 | $2,020 |
| 7 | Fix Valve Pit leaks | $2.78 | 15.1 | 1.0 | 2.4 | 1,873 | 0 | 492 | $2,540 | $270 | $0 | $2,810 |
| 5 | Fix Mech Rm Leaks | $4.26 | 8.5 | 1.8 | 2.1 | 1,612 | 0 | 424 | $2,190 | $240 | $0 | $2,430 |
| 4 | Fix Plant Leaks | $4.54 | 5.4 | 2.8 | 1.5 | 1,091 | 0 | 287 | $1,480 | $160 | $0 | $1,640 |
| 11 | Leak Locator | $55.50 | 1.5 | 9.6 | 0.1 | 76 | 0 | 20 | $100 | $10 | $5,650 | $5,760 |
| | Totals | $106.06 | NA | NA | 6.7 | 91,570 | 0 | 2,643 | $122,780 | $1,470 | $19,110 | $143,360 |

A listing of the Non-recommended ECOs is contained in Table 5.1-3. Even though some of these ECOs have SIRs greater than one and simple pay backs of less than ten years, they were not as good as other ECOs and options that provided the same function but offered greater savings.

| Table 5.1-3 SUMMARY OF NON-RECOMMENDED ECO'S | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Project | | Simple | Utility Savings (Increase) | | | | Cost Savings (Increase) | | | |
| ECO No. | Description | Cost $x1000 | SIR | Payback Years | Electric MBtu/Yr | Htg. Fuels MBtu/Yr | Fuel Oil MBtu/Yr | Water kGal/Yr | Energy $/Year | Water $/Year | O&M $/Year | Total $/Year |
| 9B | HTW Return Pump | $32.09 | 4.3 | 3.5 | 0.0 | 111 | 0 | 58 | $150 | $30 | $9,000 | $9,180 |
| 8 | Fix HTW Pipe Leaks | $127.87 | 0.6 | 25.6 | 4.3 | 3,319 | 0 | 872 | $4,510 | $480 | $0 | $4,990 |
| 1 | New HTW Piping | $24,612 | 0.2 | 99.5 | 6.5 | 177,890 | 0 | 1,317 | $238,460 | $730 | $8,120 | $247,310 |
| 10B | Shut Down SEP | $374.34 | -0.2 | 71.7 | -0.4 | 24,711 | (9,218) | 58 | ($7,450) | $30 | $12,650 | $5,230 |
| 12C | Oper. at 30 psig | $29.86 | -10.2 | 3.7 | 0.0 | 110,080 | (26,100) | 0 | $32,670 | $0 | ($24,600) | $8,070 |

The effects of implementing the No Cost/Low Cost projects ECO-9 Option A (revise SEP start-up procedure) and ECO-12 Option A (reduce operating pressure to 100 psig) are shown by Table 5.1-4. Revising the SEP start-up procedure eliminates the energy and water savings provided by ECO-10 Option A. When the operating pressure is lowered, the temperature of the HTW will be lower and the CEP heating fuel savings accomplished by reducing HTW losses will be reduced. Heating fuel savings for ECO-2, ECO-3, ECO-4, ECO-5, ECO-7, ECO-9 Option A and ECO-11 will be reduced by approximately 13.6 percent. Heating fuel savings for ECO-12 Option B will be decreased by almost 57 percent and ECO-6 will not be affected. The revised SIRs and simple pay backs indicate that all recommended ECOs remain eligible for funding.

| Table 5.1-4 SUMMARY OF RECOMMENDED ECO'S (With ECO'S 9A &12A implemented) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECO No. | Description | Project Cost $x1000 | SIR | Simple Payback Years | Utility Savings (Increase) Electric MBtu/Yr | Htg. Fuels MBtu/Yr | Fuel Oil MBtu/Yr | Water kGal/Yr | Cost Savings (Increase) Energy $/Year | Water $/Year | O&M $/Year | Total $/Year |
| 9A | SEP Start-up | $0.00 | 1000+ | 0.0 | 0.3 | 96 | 0 | 58 | $130 | $30 | $1,030 | $1,190 |
| 12A | Oper. at 100 psig | $0.00 | 1000+ | 0.0 | 0.0 | 30,244 | 0 | 0 | $40,530 | $0 | $0 | $40,530 |
| 2 | Reduce Blowdown | $0.50 | 109.0 | 0.1 | 0.0 | 864 | 0 | 263 | $1,160 | $150 | $2,360 | $3,670 |
| 3 | Reduce Soot Blow. | $0.23 | 93.3 | 0.2 | 0.0 | 1,060 | 0 | 85 | $1,420 | $50 | $0 | $1,470 |
| 10A | HTW to SEP | $6.77 | 22.1 | 0.7 | 0.0 | 0 | 0 | 0 | $0 | $0 | $10,070 | $10,070 |
| 6 | Fix HW Leaks | $1.62 | 18.5 | 0.8 | 0.0 | 1,111 | 0 | 956 | $1,490 | $530 | $0 | $2,020 |
| 12B | Oper. at 60 psig | $29.86 | 15.3 | 1.0 | 0.0 | 22,871 | 0 | 0 | $30,650 | $0 | $0 | $30,650 |
| 7 | Fix Valve Pit leaks | $2.78 | 13.3 | 1.1 | 2.4 | 1,619 | 0 | 492 | $2,200 | $270 | $0 | $2,470 |
| 5 | Fix Mech Rm Leaks | $4.26 | 7.4 | 2.0 | 2.1 | 1,393 | 0 | 424 | $1,900 | $240 | $0 | $2,140 |
| 4 | Fix Plant Leaks | $4.54 | 4.7 | 3.2 | 1.5 | 943 | 0 | 287 | $1,280 | $160 | $0 | $1,440 |
| 11 | Leak Locator | $55.50 | 1.5 | 9.7 | 0.1 | 66 | 0 | 20 | $90 | $10 | $5,650 | $5,750 |
| | Totals | $106.06 | NA | 1.0 | 6.4 | 60,267 | 0 | 2,585 | $80,850 | $1,440 | $19,110 | $101,400 |

Implementing ECO-12 Option B (reduce operating pressure to 60 psig) will reduce the heating fuel savings even further. The results of installing this project are shown by Table 5.1-5. Heating fuel savings for ECO-2, ECO-3, ECO-4, ECO-5, ECO-7, ECO-9 Option A and ECO-11 will be reduced by an additional 11.6 percent. Heating fuel savings for ECO-12 Option B will and ECO-6 will not be affected. The revised SIRs and simple pay backs still indicate that all recommended ECOs remain eligible for funding.

| Table 5.1-5 SUMMARY OF RECOMMENDED ECO'S (With ECO'S 9A, 12A & 12B implemented) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECO No. | Description | Project Cost $x1000 | SIR | Simple Payback Years | Utility Savings (Increase) Electric MBtu/Yr | Htg. Fuels MBtu/Yr | Fuel Oil MBtu/Yr | Water kGal/Yr | Cost Savings (Increase) Energy $/Year | Water $/Year | O&M $/Year | Total $/Year |
| 9A | SEP Start-up | $0.00 | 1000+ | 0.0 | 0.3 | 85 | 0 | 58 | $120 | $30 | $1,030 | $1,180 |
| 12A | Oper. at 100 psig | $0.00 | 1000+ | 0.0 | 0.0 | 30,244 | 0 | 0 | $40,530 | $0 | $0 | $40,530 |
| 2 | Reduce Blowdown | $0.50 | 105.1 | 0.1 | 0.0 | 765 | 0 | 263 | $1,030 | $150 | $2,360 | $3,540 |
| 3 | Reduce Soot Blow. | $0.23 | 82.8 | 0.2 | 0.0 | 937 | 0 | 85 | $1,260 | $50 | $0 | $1,310 |
| 10A | HTW to SEP | $6.77 | 22.1 | 0.7 | 0.0 | 0 | 0 | 0 | $0 | $0 | $10,070 | $10,070 |
| 6 | Fix HW Leaks | $1.62 | 18.5 | 0.8 | 0.0 | 1,111 | 0 | 956 | $1,490 | $530 | $0 | $2,020 |
| 12B | Oper. at 60 psig | $29.86 | 15.3 | 1.0 | 0.0 | 22,871 | 0 | 0 | $30,650 | $0 | $0 | $30,650 |
| 7 | Fix Valve Pit leaks | $2.78 | 11.9 | 1.3 | 2.4 | 1,432 | 0 | 492 | $1,950 | $270 | $0 | $2,220 |
| 5 | Fix Mech Rm Leaks | $4.26 | 6.7 | 2.2 | 2.1 | 1,232 | 0 | 424 | $1,680 | $240 | $0 | $1,920 |
| 4 | Fix Plant Leaks | $4.54 | 4.3 | 3.5 | 1.5 | 834 | 0 | 287 | $1,130 | $160 | $0 | $1,290 |
| 11 | Leak Locator | $55.50 | 1.5 | 9.7 | 0.1 | 58 | 0 | 20 | $80 | $10 | $5,650 | $5,740 |
| | Totals | $106.06 | NA | 1.1 | 6.4 | 59,569 | 0 | 2,585 | $79,920 | $1,440 | $19,110 | $100,470 |

## 5.2 O&M RECOMMENDATIONS

### Central Energy Plant

1. Reduce boiler and HTW system pressure to 100 psig. All that is necessary to accomplish this is to slowly reduce the CEP plant master pressure controller from 180 psig to 100 psig. Reduce boiler and HTW system pressure to 100 psig. Reducing the boiler and HTW system operating pressure and temperature will reduce the heat losses from the system to the surroundings. Operating at lower pressures will also result in less stress on the system components, including pumps, valves, fittings, etc., and should reduce losses from existing HTW leaks. The only possible negative effect of operating at lower pressures and temperatures is not meeting the required heating set point in the buildings. If the end use systems cannot maintain the desired temperatures during the winter months, the pressure can be adjusted up until all requirements are satisfied.

2. Inspect boiler No. 4 tubes. The boiler tubes that face the soot blower should be carefully inspected annually. This inspection should include a measurement of the tubes' outer diameter with a micrometer to determine the rate of tube metal erosion. It is better to replace a tube that is near the end of its useful life than to have it fail during operation.

3. Repair miscellaneous HTW leaks. The operators should be aware of and fix miscellaneous HTW leaks (even small ones) that occur from valves, pumps and fittings in the CEP as soon as they are discovered.

4. Shut off the atomizing steam line. Boiler Number 4 burns wood about 90 percent of the time. This boiler is also equipped with an auxiliary oil fired burner. The oil burner uses steam to atomize the oil. The oil burner operates about 10 percent of the time to burn waste oil when available, or to burn No. 2 fuel oil when the flow of wood to the boiler is interrupted. The atomizing steam valve is left open to make the transition from wood to oil quick and easy because an interruption of wood flow can occur suddenly. With the atomizing steam already flowing through the burner, operator need only start the ignitor and open the fuel oil valve to establish a support energy input. When this valve is left open, steam is continuously venting into the furnace which wastes energy and water.

   It would take the operator longer to light off the oil burner if the atomizing steam valve were kept closed. The operator would have to leave the control panel and walk out to the boiler to either start the burner manually, or set it up (by turning on the atomizing steam) to be started remotely. This means the operator is required to be in two places at once; in the control room trying to establish wood flow, and outside setting up the oil burner to be brought into service in the event he can not establish wood flow. The atomizing steam valve should be left just slightly open during the winter months to

prevent freezing and shut off during the rest of the year. If this is too much of an inconvenience to the operators, the CEP staff should consider switching to air atomization. Air atomization is also better for cold starts.

5. Shut off soot blower steam line. The soot blower system consists of the blowers and a steam piping system from the steam drum to the blowers. A steam trap located near the bottom of the system keeps the system free of condensate. The trap appears to be leaking and allowing steam to pass directly to the blow down tank. This trap should be repaired as indicated by O&M Recommendation Number 8. Shutting off the soot blower steam supply valve at the drum is a temporary way of stopping the energy loss until the malfunctioning steam trap can be repaired. This will require that the operator walk up to the top of the boiler to open and close the supply valve located on the steam drum. When the recommendation to reduce the soot blowing frequency is implemented, the effort will be reduced. When the steam trap is repaired this effort will be eliminated.

6. Provide properly operating level controls for all major process vessels. The CEP and SEP require constant attention and vigilance by the operators to keep control of the water levels in the various pressure vessels. Furthermore, since the plant never really comes to steady state because the levels in the vessels are constantly changing, conducting short term tests can produce dubious results. As an example, the makeup water flow to the system varies considerably on a daily basis without any reasonable explanation. Tank level controls would steady the entire process and reduce the labor required to operate it.

7. Remove and reinstall the No. 4 boiler rear water wall header blowdown valves. These valves are currently installed backwards.

8. Repair/replace the leaking steam traps on the No. 4 boiler. It was reported that the steam traps on the No. 4 boiler have not received any maintenance since their original installation. Some are leaking badly.

9. Repair the steam turbine driven boiler feed pump (BFP). This pump is an emergency piece of equipment designed to provide the necessary feed water to the boiler in the event of a power failure. A stoker-fired boiler has a considerable amount of unburned fuel on the furnace grate at any given time. In the event of a power failure, the electrically driven boiler feed pumps would be inoperative. The unburned fuel will continue to be consumed by air that is drawn into the boiler through natural draft. The heat released from the burning grate fuel will continue to evaporate the water in the steam drum. If the drum level is not maintained above a minimum low level, tube overheating and damage

may result. The turbine driven BFP is there to provide the water to the boiler drum until the fuel in the furnace is consumed.

**Satellite Energy Plant**

1. Repair miscellaneous HTW leaks. The operators should be aware of and fix miscellaneous HTW leaks (even small ones) that occur from valves, pumps and fittings in the SEP as soon as they are discovered.

2. Improve start-up procedure for the SEP. Changing the SEP start-up procedures could eliminate the need to discharge HTW and also reduce the labor effort required during start up. The modified SEP start-up procedure is described in ECO-9 Option A.

3. Provide status indication of all SEP pumps in the No. 4 boiler control room. At a minimum, the operator in the CEP should be able to determine the pump motor status at the SEP. Ideally, he should have complete remote automatic control of all rotating equipment and vessel levels. Providing this process control would substantially reduce the labor required to operate the SEP.

**Mechanical Equipment Rooms**

1. Inspect mechanical equipment room more frequently. The maintenance staff currently go in the mechanical equipment rooms two times per year, once for the winter-to-summer changeover and once for the summer-to-winter changeover. There should be two more visits scheduled each year to keep the miscellaneous HTW, HHW, DHW and CHW leaks to a minimum. All that is required is a quick look at the mechanical room floor. If there are any wet spots then there is a leak. The maintenance person should carry a wrench to tighten flanges, fittings and valve stems.

2. Repair and/or adjust domestic hot water temperature controls in Buildings 504, 516, 517, 518, 629, 631, 632, 637, 701, 702 and 1720. The DHW temperature in these buildings ranges from 142 degrees F to 183 degrees F. These controls should be set to maintain a DHW temperature between 120 degrees F and 140 degrees F.

3. Check the heat exchangers for leaks in Buildings 207, 212, 503, 504, 512, 516, 517, 518, 608, 642, 720 and 726. The water analysis for these buildings indicate the possibility of the HTW leaking into the DHW.

## Valve Pits, Drain Pits and Valve Boxes

1. Repair or replace inoperable sump pumps. There were many valve pits with inoperable sump pumps. In some cases, the water level was up to the HTW pipes. Allowing the pipe insulation to get wet dramatically increases the thermal losses from the system. The sump pumps should be repaired. The exact locations of the inoperable sump pumps can be obtained from the summary list and survey forms in Appendix B.1.

2. Remove the two trees that are growing in the Zone 3 valve pit located at the west corner where Wilson Avenue intersects West 4th Street.

3. The survey of the valve pits indicated that many of the HTW conduits were leaking. A conduit leak is occurring when steam blows from the conduit vents intermittently and the venting stops after a period of dry weather. Conduit leaks allow ground water to flow into the cavity between the HTW pipe and the conduit. The ground water is evaporated by the HTW piping and the resulting steam escapes through the conduit vents. The escaping steam represents a significant energy and economic loss.

   The magnitude and source of the conduit leaks can be determined by installing a drain valve (or threaded pipe plug) in the bottom of the conduit seal plate in the pits. When a leak occurs, chemical analysis would show if the water draining from the opening was ground water or HTW. If the leak is ground water, the valve should be left open so the water can drain out of the conduit instead of being evaporated. This would reduce the thermal losses from the HTW system. If the leak was determined to be HTW, the magnitude of the leak could be measured using a container and a watch. This measurement would provide an objective basis for the economic justification of repairing the leak.

# 6.0 FEMP PROJECT PROGRAMMING DOCUMENTS

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-4 Repair HTW and steam leaks in the CEP and the SEP.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

# PROGRAMMING DOCUMENTATION - FEMP

## ATTACHMENT 1

## DESCRIPTION OF WORK

## ECO Number 4

Repair HTW and steam leaks in the CEP and the SEP.

**Description**

A number of HTW leaks were discovered during the survey of the CEP and the SEP. The locations were generally at "joints" in the piping system such as flanges, valve packings, valve bonnets and pump seals. This project includes the replacement of some valves and steam traps and tightening the bolts on other various flanges, fittings and valve stems.

Most of the miscellaneous HTW leaks in the CEP are from the HTW zone pump packing glands. Pumps P-10 and P-11 have significant leaks and Pumps P-4, P-5, P-23 and P-24 have only minor leaks. There are also small leaks from seven of the valves and fittings on the three cascade heaters and the deaerator. Because the pumps have such a high operating pressure, the economic analysis assumes that only about 50 percent of these leaks can be repaired.

The leaks in the CEP associated with Unit Number 4 include two leaking blowdown valves on the rear water wall header, leaking steam traps on the main steam line, soot blower warm-up line and the boiler feed pump turbine line and continuous operation of the atomizing steam when no oil is being burned. The economic analysis assumes that approximately 90 percent of these leaks can be repaired.

Miscellaneous leaks in the SEP consist mainly of leaking blowdown valves on both of the cascade heaters and an HTW supply check valve. There are also very small leaks in the east cascade heater gauge glass and steam stop valve and in the west cascade heater equalization valve. The economic analysis assumes that all of these leaks can be repaired.

The following table shows the current and target leak quantities. The exact locations and leak estimates are located in Attachment 3.

| Location | Current (gpm) | % Reduction | Proposed (gpm) |
|---|---|---|---|
| Misc. CEP Leaks | 0.207 | 50 | 0.104 |
| Boiler Number 4 | 0.232 | 90 | 0.023 |
| Misc. SEP Leaks | 0.233 | 100 | 0.000 |
| Total | 0.672 | | 0.127 |

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-4
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 4057. | | |
| B. SIOH | $ 244. | | |
| C. DESIGN COST | $ 244. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4545. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4545. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 21. | 15.08 | $ 311. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1091. | $ 1462. | 14.88 | $ 21754. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1093. | $ 1483. | | $ 22064. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1643.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.77 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 24445.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 5.38
(IF < 1 PROJECT DOES NOT QUALIFY)

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

RS&H

SUBJECT FORT STEWART
Repair CEP & SEP Leaks
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 1 OF
DATE 2-12-96
DATE

ECO-4 REPAIR HTW AND STEAM LEAKS IN THE CEP AND SEP

The quantities of HTW losses are listed below and the calculations can be found on the following pages:

Misc. CEP Leaks = 0.207 gpm = 298 GPD

These leaks are all from valves stems, fittings and pump glands. It is hard for the pump glands to handle the high system operating pressure so we assumed that only about 50% of these leaks could be repaired.

Boiler No. 4 Leaks = 0.232 gpm = 334 GPD

These leaks include 3 faulty steam traps and two blowdown valves. Assume new steam traps and valves will reduce these leaks by about 90%.

Misc. SEP Leaks = 0.233 gpm = 336 GPD

These leaks are mainly due to leaking blowdown valves on the cascade heaters. Assume replacing the blowdown valves and tightening the other valves will eliminate 100% of these leaks.

Current HTW Losses = $(298 + 334 + 336)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{353320\ \frac{\text{Gal}}{\text{YR}}}$

Proposed HTW Losses = $(298 \times 0.5 + 334 \times 0.1)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{66580\ \frac{\text{Gal}}{\text{YR}}}$

RS&H.

SUBJECT FORT STEWART
REPAIR CEP & SEP LEAKS
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-12-96
DATE

ECO-4 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1344 - 253 = $\boxed{1091 \text{ mBtu/YR}}$

ELECTRICITY = 1.8 - 0.3 = $\boxed{1.5 \text{ mBtu/YR}}$

WATER = \$197 - \$37 = $\boxed{\$160\text{/YR}}$

ECO-4

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in the CEP and SEP | Date: | 02/12/96 |
| ECO Number: | 4 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

353320 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 914.0 MBtu/Yr

Heating Fuel Use = 914.0 MBtu/yr / 0.68 = 1344.1 MBtu/Yr

Heating Fuel Cost = 1344.1 MBtu/yr x $1.34 /MBtu = $1,801 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.071 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.071 BHP / 0.90 x 0.746 kW/HP = 0.059 kW

Electricity Use = 0.059 kW x 8760 Hr/Yr = 514 kWh/Yr

Electricity Use = 514 kWh/Yr x 0.003413 MBtu/kWh = 1.75 MBtu/Yr

Electricity Cost = 514 kWh/Yr x $0.0469 /kWh = $24 /Year

Water Cost:

353320 Gal/Yr x $0.5562 /kGal = $197 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $1,801 | /Year |
| Pumping (Elec) Cost | $24 | /Year |
| Water Cost | $197 | /Year |
| Total Utility Cost | $2,022 | /Year |

ECO-4

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in the CEP and SEP | Date: | 02/12/96 |
| ECO Number: | 4 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

66580 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 172.2 MBtu/Yr

Heating Fuel Use = 172.2 MBtu/yr / 0.68 = 253.3 MBtu/Yr

Heating Fuel Cost = 253.3 MBtu/yr x $1.34 /MBtu = $339 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.13 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.013 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.013 BHP / 0.90 x 0.746 kW/HP = 0.011 kW

Electricity Use = 0.011 kW x 8760 Hr/Yr = 97 kWh/Yr

Electricity Use = 97 kWh/Yr x 0.003413 MBtu/kWh = 0.33 MBtu/Yr

Electricity Cost = 97 kWh/Yr x $0.0469 /kWh = $5 /Year

Water Cost:

66580 Gal/Yr x $0.5562 /kGal = $37 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $339 | /Year |
| Pumping (Elec) Cost | $5 | /Year |
| Water Cost | $37 | /Year |
| Total Utility Cost | $381 | /Year |

# CEP MISCELLANEOUS LEAKS

Valves & Fittings:

| | Leak Rate Estimate |
|---|---|
| **Cascade Heater No. 1** | |
| - Valve to top of sight glass leaking steam | 2 drop/sec |
| - Valve on top left of heater leaking steam | 2 " |
| **Cascade Heater No. 2** | |
| - Valve on bottom left of heater leaking steam | 2 " |
| **Cascade Heater No. 3** | |
| - Valve on top of sight glass leaking steam | 2 " |
| **Deacrator Tank** | |
| - Strainer next to control valve leaking steam and about 3 drops/second HTW. | 5 " |
| - Valve above stairs leaking steam | 2 " |
| - Vent to outside blowing steam (intermittant) | 2 " |
| Total valves & fittings leaks | 17 drops/sec |

$$17 \text{ drops/second} \times 2.5\times10^{-3} \frac{\text{gpm}}{\text{d/s}} = \underline{0.042 \text{ gal/min}}$$

HTW Zone Pumps:

- P-4 & P-5 ~ 1 drop / 4 seconds = 0.0006 GPM
- P-10 ~ steady 1/8" stream * = 0.109 GPM
- P-11 ~ Intermittant 1/8" stream* = 0.054 GPM

**RS&H.**

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart CEP Misc. Leaks | AEP NO | 694 1331 002 |
| DESIGNER | W. Todd | SHEET | 2 OF 2 |
| CHECKER | | DATE | 2-2-96 |
| | | DATE | |

Pumps (continued)

- P-23 & P-24 ~ 2 drops / 3 seconds = 0.0017 GPM

* A 1/8" stream was measured and timed and found to be ~1.75 cups/min ÷ 16 $\frac{\text{cups}}{\text{gal}}$ ≈ 0.109 GPM

Total leaks from HTW Pumps = 0.165 GPM

Total Miscellaneous CEP Leaks:

| | |
|---|---|
| Valves & Fittings | 0.042 GPM |
| HTW Zone Pumps | 0.165 GPM |
| Total = | 0.207 GPM |

ECO-4

## Central Energy Plant (CEP) Leak Test #4 Boiler

On November 30, 1995 a leak test was conducted at CEP to determine the extent of the leaks associated with Boiler No.4. A significant amount of steam continually vents from the No.4 blowdown tank. To quantify this loss, a CEP leak test would be conducted with the No.4 boiler configured in as a "tight" a mode as possible, and then a second test would be conducted with No.4 in a "normal" (leaky) configuration. The difference in the test results would be the leaks due to No. 4's normal configuration.

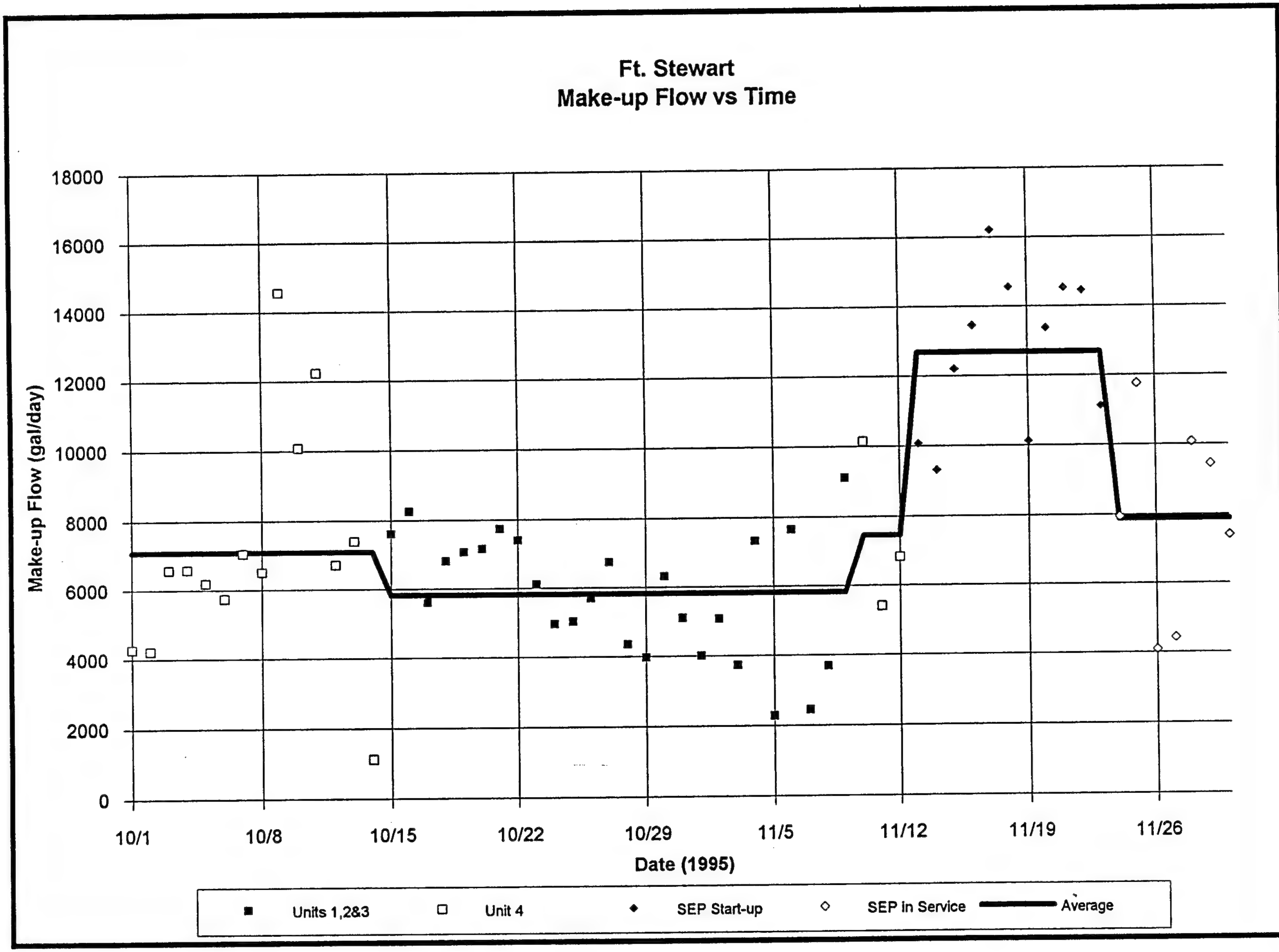
The leak test consists of measuring the make-up water required to maintain constant heater levels over an 8 hour period. Unfortunately, the test results showed no heater level changes over the 6 hour test period when a 6-7 inch change in the gauge glass level was expected. This testing technique has yielded results in the past. No explanation for the lack of results was determined; however, improper system valving is strongly suspected.

Configuring the boiler in as tight a configuration as possible stopped the blowdown tank steam venting. Leaking steam traps in the main steam line, the soot blower warm-up line, and in the boiler feed pump turbine line are the sources of the steam venting. Furthermore, the rear water wall header blowdown valves are leaking slightly. This leak was so small that only warm water entered the blow down tank.

A graph (enclosed) of the daily make-up consumption data shows a wide scattering of data, perhaps lending credence to the suspicion that observing heater tank levels over a short period of time (8 hours) yields uncertain results. However, when averaged over longer periods of time (weeks), yields more reliable results. The graph shows the daily make-up consumption (DMC) prior to October 15, 1995 averaged about 7000 gpd (4.86 gpm) while unit 4 alone was operating. During the period October 15 through November 10, 1995 unit 4 was shut down and units 1,2 and 3 were operating, and the DMC fell to 5900 gpd (4.10 gpm). This reduction in DMC can be attributed to two principal causes; 1) the general leaky state of unit No. 4; and 2) the required consumption of steam for sootblowing. The magnitude of the change 1100 gpd (0.764 gpm) seems reasonable. The fact that the consumption returned to the original levels when 4 boiler was returned to service implies that some of the leaks are in fact related to unit No. 4.

### No. 4 Boiler Operation Recommendations

1. Repair steam trap leaks.
2. Reduce soot blowing frequency. Change from a time based operation to an exit gas temperature based operation.
3. Reduce blow down frequency to maintain American Boiler Manufacturers Association standard of 3500 ppm total dissolved solids.


Ft. Stewart
Make-up Flow vs Time
Make-up Flow (gal/day)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
10/1
10/8
10/15
10/22
10/29
11/5
11/12
11/19
11/26
Date (1995)
Units 1,2&3
Unit 4
SEP Start-up
SEP In Service
Average

Satellite Energy Plant (SEP) Leak test.

On November 29, 1995 the SEP was tested for system leaks. The testing procedure consists of stopping all steam flow to, and condensate return flow from, the SEP, and measuring the decrease in the level of the two cascade heaters in the SEP. By calculating the volume change in the heaters, a leak rate may be determined.

| | | | | | |
|---|---|---|---|---|---|
| Time (EST) | 9:46 | 10:34 | 11:13 | 11:37 | 11:48 |
| Level (in) | 14.3 | 14.3 | 14.3 | 14.3 | 14.3 |
| Temp (°F) | 375 | 360 | 340 | 335 | 330 |
| Pres. (psig) | 190 | 140 | 115 | 105 | 100 |

The data from the 2 hour test indicated that the water level in the heaters never changed while the circulating hot water showed a -45° temperature change and a -90 psig pressure change. It was concluded therefore the SEP system was "tight".

It is important to note however that the testing method used is quite crude over the short time period of the test. The two, 4000 gallon, cascade heaters are connected by symmetrical piping assuring "equal" water levels in both heaters. A one inch change in water level, at normal operating level, would be equivalent to 140 gallons of water. The leaks found and measured during the test are tabulated below.

| Location | Amount (gpm) |
|---|---|
| East Heater gauge glass | $2.23 \times 10^{-4}$ |
| East Heater Steam Stop valve | $2.11\times10^{-3}$ |
| West Heater Equalization valve | $1.00\times10^{-3}$ |
| HTWS Check Valve | 0.03 |
| Both Heaters blow down valves | 0.2 |
| **TOTAL** | **0.233** |

The total amount of water lost during the test is 0.233 gpm x 122 min. = 29 gals., or approximately 0.2 inches on the gauge glass. With normal, slow, level swings (generally attributable to sloshing) between the tanks, this leak rate is barley detectable in the sight glass over the time span of the test. Because of the large heater storage capacity, a longer test period is warranted. In the future this test could be a reasonable leak detection and quantification method at the SEP if conducted over longer testing periods. The best time for the test would be when the heat load from the SEP is minimal, perhaps on a warm day after a cool night.

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Leaks in the CEP and SEP
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 4

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-4.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Travel time to bldgs. | 0.5 | hr | | 0 | 30.3 | 15 | 15 | | (1) |
| Repair/tighten valves | 2.8 | hr | | 0 | 30.3 | 83 | 83 | | (2) |
| Remove Steam Traps | 3 | Ea | | 0 | 34.5 | 104 | 104 | | MMp264 |
| Steam Trap, 1", 600 lb | 3 | Ea | 660 | 1980 | 34.5 | 104 | 2,084 | MMp264 | MMp264 |
| Remove valves | 4 | Ea | | 0 | 52.8 | 211 | 211 | | MMp191 |
| 2" gate valve, 250 lb | 4 | Ea | 256 | 1024 | 52.8 | 211 | 1,235 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 3004 | | 728 | $3,732 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 3004 | | 728 | 3,732 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -322 | (322) | MMp533 | MMp533 |
| Subtotal | | | | 3004 | | 406 | 3,410 | | |
| OH & Profit Markups | | | 10% | 300 | 53% | 215 | 515 | MMp7 | MMp475 |
| Subtotal | | | | 3304 | | 621 | 3,925 | | |
| Sales Taxes | | | 4.0% | 132 | | NA | 132 | MMp476 | |
| Total Construction Cost | | | | 3436 | | 621 | 4,057 | | |
| Design Fee | | | | NA | 6.0% | 243 | 243 | | |
| SIOH | | | | NA | 6.0% | 243 | 243 | | |
| Subtotal | | | | 3436 | | 1107 | 4,543 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 3436 | | 1107 | $4,543 | | |

LEGEND:
(1) Estimate 30 minutes for CEP to SEP round trip.
(2) Estimate 15 minutes per valve for 11 valves.
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-4

## Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-5 Repair HTW leaks in the mechanical equipment rooms.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 1

DESCRIPTION OF WORK

## ECO Number 5

Repair HTW leaks in the mechanical equipment rooms.

**Description**

This project involves tightening the bolts on flanges and valve stems within the mechanical equipment rooms served by the HTW system. There may also be some valves that must be replaced. The survey of the mechanical equipment rooms revealed leaking valves and flanges in 42 of the 127 rooms surveyed. There were a total of 36 leaking valves and 14 leaking flanges. The locations of the leaking valves and fittings is contained in Attachment 3. The total estimated HTW losses from valves and fittings within the mechanical equipment rooms are 0.88 GPM (1,260 GPD). The energy savings calculations and economic analysis assume that all of the eight major leaks and about 50 percent of the 38 minor leaks can be repaired. Approximately 1,160 GPD of the HTW leaks in the mechanical equipment rooms would be eliminated.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-5

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-5
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 3804. | | |
| B. SIOH | $ 229. | | |
| C. DESIGN COST | $ 229. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4262. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4262. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 29. | 15.08 | $ 435. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1612. | $ 2160. | 14.88 | $ 32142. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1614. | $ 2189. | | $ 32577. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2424.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.76 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 36074.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 8.46
(IF < 1 PROJECT DOES NOT QUALIFY)

## PROGRAMMING DOCUMENTATION - FEMP

## ATTACHMENT 3

## CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

RS&H

| | |
|---|---|
| SUBJECT | FORT STEWART REPAIR MECH. RM. LEAKS |
| DESIGNER | W. TODD |
| CHECKER | |
| AEP NO | 594 1331 002 |
| SHEET | OF |
| DATE | 2-9-96 |
| DATE | |

ECO-5 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1750 − 138. = $\boxed{1612 \text{ mBtu/YR}}$

ELECTRICITY = 2.3 − 0.2 = $\boxed{2.1 \text{ mBTU/YR}}$

WATER = \$256 − \$20 = $\boxed{\$236\text{/YR}}$

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | Existing Leaks in Mech. Rooms |
| ECO Number: | 5 |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/08/96

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

459900 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1189.7 MBtu/Yr

Heating Fuel Use = 1189.7 MBtu/yr / 0.68 = 1749.6 MBtu/Yr

Heating Fuel Cost = 1749.6 MBtu/yr x $1.34 /MBtu = $2,344 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.88 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.09 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.09 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 669 kWh/Yr

Electricity Use = 669 kWh/Yr x 0.003413 MBtu/kWh = 2.3 MBtu/Yr

Electricity Cost = 669 kWh/Yr x $0.0469 /kWh = $31 /Year

Water Cost:

459900 Gal/Yr x $0.5562 /kGal = $256 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,344 | /Year |
| Pumping (Elec) Cost | $31 | /Year |
| Water Cost | $256 | /Year |
| Total Utility Cost | $2,631 | /Year |

ECO-5

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in Mech. Rooms | Date: | 02/08/96 |
| ECO Number: | 5 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

36260 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 93.8 MBtu/Yr

Heating Fuel Use = 93.8 MBtu/yr / 0.68 = 137.9 MBtu/Yr

Heating Fuel Cost = 137.9 MBtu/yr x $1.34 /MBtu = $185 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 53 kWh/Yr

Electricity Use = 53 kWh/Yr x 0.003413 MBtu/kWh = 0.2 MBtu/Yr

Electricity Cost = 53 kWh/Yr x $0.0469 /kWh = $2 /Year

Water Cost:

36260 Gal/Yr x $0.5562 /kGal = $20 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $185 | /Year |
| Pumping (Elec) Cost | $2 | /Year |
| Water Cost | $20 | /Year |
| Total Utility Cost | $207 | /Year |

**RS&H.**

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart<br>Repair Leaks in ME Rooms | AEP NO | 694 1331 002 |
| | | SHEET | OF |
| DESIGNER | W. Todd | DATE | 2-6-96 |
| CHECKER | | DATE | |

## HTW Losses

The spreadsheet on the following pages lists the leaks found in all of the mechanical rooms. The leaks were measured with a beaker and timed with a stopwatch.

Major Leaks:

There are 8 major leaks totaling 0.737 GPM

$$0.737 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} = 387{,}370 \text{ GAL/YR}$$

Assume all of these leaks can be repaired.

Minor Leaks:

There are 38 minor leaks totaling 0.138 GPM

Assume 50% of the leaks can be repaired.

$$0.138 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{Yr}} \times 0.5 = 36{,}270 \text{ GAL/YR}$$

$$\text{Current HTW losses} = 0.875 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} = \underline{459900 \frac{\text{GAL}}{\text{YR}}}$$

$$\text{Savings} = (387{,}370 + 36270) \text{ GAL/YR} = 423640 \frac{\text{GAL}}{\text{YR}}$$

$$\text{New HTW losses} = 459{,}900 \frac{\text{GAL}}{\text{YR}} - 423{,}640 \frac{\text{GAL}}{\text{YR}} = \underline{36260 \frac{\text{GAL}}{\text{YR}}}$$

There are 36 leaking valves. Assuming 25% of them will have to be replaced:

$$36 \text{ valves} \times .25 \Rightarrow 9 \text{ valves to be replaced}$$

ECO-5

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 206 | 3 | Learning Center | 80 | DHW | Y | Y | Y | 2.00 | 0.33 |
| 207 | 3 | Dining Facility | 124 | DHW | Y | N | N | | |
| 208 | 3 | Fitness Center | 113 | DHW | Y | Y | N | 0.06 | |
| 211 | 3 | Admin. | N/A | N/A | Y | Y | N | 4.00 | |
| 212 | 3 | Admin/Barracks | 131 | DHW | Y | N | N | | |
| 213 | 3 | Barracks | 120 | DHW | Y | N | N | | |
| 215 | 3 | Barracks | 137 | DHW | Y | Y | N | 2.00 | 1.50 |
| 216 | 3 | Barracks | 110 | DHW | Y | Y | N | 2.50 | |
| 217 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.13 | |
| 218 | 3 | Barracks | 124 | DHW | Y | N | Y | | |
| 223 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.17 | |
| 224 | 3 | Admin. | N/A | N/A | Y | Y | N | 5.00 | 6.67 |
| 225 | 3 | Admin. | N/A | N/A | Y | N | N | | |
| 230 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 241 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 260 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 270 | 3 | Tac Equip Shop | N/A | N/A | Y | Y | N | 2.20 | |
| 276 | 3 | Tac Equip Shop | N/A | N/A | N | | | | |
| 302 | 3 | Hospital | 137 | DHW | Y | N | N | | |
| 403 | N/A | Child Care Ctr | N/A | N/A | Y | N/A | N | | |
| 439 | N/A | Fitness Center | 139 | DHW | Y | N/A | N | | |
| 440 | 2 | Dental Clinic | 114 | DHW | Y | N | N | | |
| 501 | 2 | Barracks | 134 | DHW | Y | Y | N | 0.33 | |
| 503 | 2 | Barracks | 122 | DHW | Y | Y | N | 2.00 | 0.25 |
| 504 | 2 | Barracks | 158 | DHW | Y | Y | N | | 0.75 |
| 506 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 507 | 2 | Admin. | N/A | N/A | Y | Y | N | 1.00 | |
| 508 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 509 | 2 | Admin. | N/A | N/A | Y | N | Y | | |
| 512 | 2 | Dining Facility | 145 | DHW | Y | ? | Y | | 1.17 |
| 514 | 2 | Barracks | 126 | DHW | Y | Y | N | 1.25 | |
| 515 | 2 | Barracks | 123 | DHW | Y | N | Y | | |
| 516 | 2 | Barracks | 145 | DHW | Y | ? | Y | | |
| 517 | 2 | Barracks | 175 | DHW | LOCKED | | | | |
| 518 | 2 | Barracks | 183 | DHW | Y | ? | Y | 3.33 | |
| 520 | 2 | Admin. | N/A | N/A | Y | N | Y | | |
| 521 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.50 | |
| 522 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.25 | |
| 523 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 524 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 525 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.09 | |

ECO-5

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 608 | 2 | Fitness Center | 127 | DHW | Y | Y | N | 0.08 | |
| 610 | 2 | Chapel | 115 | DHW | Y | N | N | | |
| 612 | 2 | Admin. | N/A | N/A | Y | Y | Y | 0.08 | |
| 614 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 616 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 617 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 618 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 619 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 620 | 1 | Admin. | 112 | DHW | Y | N | N | | |
| 621 | 1 | Admin. | 91 | DHW | Y | N | N | | |
| 622 | 1 | Admin. | 85 | DHW | Y | N | N | | |
| 623 | 1 | Admin. | 109 | DHW | Y | N | Y | | |
| 624 | 1 | Admin. | 109 | DHW | Y | N | Y | | |
| 626 | 1 | Dining Facility | 145 | DHW | Y | N | N | | |
| 628 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | |
| 629 | 1 | Barracks | 160 | DHW | Y | ? | Y | | |
| 630 | 1 | Barracks | 117 | DHW | Y | N | Y | | |
| 631 | 1 | Barracks | 142 | DHW | Y | Y | Y | | 0.88 |
| 632 | 1 | Barracks | 160 | DHW | Y | N | Y | | |
| 633 | 1 | Barracks | 128 | DHW | Y | Y | Y | 2.00 | |
| 634 | 1 | Barracks | LOCKED | LOCKED | Y | N | N | | |
| 635 | 1 | Barracks | 140 | DHW | Y | Y | N | 1.59 | |
| 636 | 1 | Barracks | 138 | DHW | Y | Y | Y | 1.22 | |
| 637 | 1 | Barracks | 158 | DHW | Y | N | N | | |
| 638 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 639 | 1 | Admin. | N/A | N/A | Y | Y | N | 1.56 | |
| 640 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 641 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 642 | 1 | Dining Facility | 154 | DHW | Y | N | Y | | |
| 643 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.10 | |
| 644 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.33 | |
| 645 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 646 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 647 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | |
| 648 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 649 | 1 | Admin. | N/A | N/A | Y | N | N | | |

ECO-5

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 701 | 1 | Health Clinic | 152 | DHW | Y | Y | N | 1.00 | |
| 702 | 1 | Ent. Center | 143 | DHW | Y | N | N | | |
| 703 | 1 | Enl. Mens Club | N/A | N/A | LOCKED | | Y | | |
| 704 | 1 | Theater | N/A | N/A | Y | N | Y | | |
| 706 | 1 | Branch Exchange | N/A | N/A | Y | N | Y | | |
| 708 | 1 | Fitness Center | 131 | DHW | Y | N | Y | | |
| 710 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 712 | 1 | Barracks | 135 | DHW | Y | N | Y | | |
| 713 | 1 | Barracks | 133 | DHW | Y | N | Y | | |
| 714 | 1 | Barracks | 137 | DHW | Y | N | Y | | |
| 715 | 1 | Barracks | 135 | DHW | Y | Y | N | 0.20 | |
| 717 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 718 | 1 | Barracks | 124 | DHW | Y | Y | Y | 0.20 | |
| 719 | 1 | Barracks | 112 | DHW | Y | Y | N | 1.00 | |
| 720 | 1 | Barracks | 130 | DHW | Y | N | Y | | |
| 721 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 722 | 1 | Admin. | N/A | N/A | Y | Y | Y | 5.00 | |
| 723 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 724 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 725 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 726 | 1 | Dining Facility | 158 | DHW | Y | N | Y | | |
| 727 | N/A | Training Facility | N/A | N/A | Y | N/A | N | | |
| 728 | 1 | Admin. | N/A | N/A | Y | Y | N | 3.05 | |
| 810 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 811 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 812 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 813 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 814 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 815 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 816 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 818 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 819 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.13 | |

ECO-5

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 1160 | 3 | D.S. Maint Fac | N/A | N/A | Y | Y | N | 2.03 | |
| 1170 | 3 | G.S. Maint Fac | N/A | N/A | Y | N | N | | |
| 1208 | 1 | Tac Equip Shop | N/A | N/A | Y | N | Y | | |
| 1209 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1211 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1245 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | |
| 1259 | 1 | Tac Equip Shop | N/A | N/A | Y | Y | N | | 0.25 |
| 1261 | 2 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1265 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1280 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | |
| 1320 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1330 | 2 | Tac Equip Shop | N/A | N/A | Y | Y | N | 0.13 | |
| 1340 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1412 | | C. Energy Plant | N/A | HTW | Y | Y | | | |
| 1500 | 3 | Div Logis Fac | N/A | N/A | w/ 1509? | | | | |
| 1503 | 3 | Auto Hobby Shop | N/A | N/A | LOCKED | | | | |
| 1509 | 3 | Div Logis Fac | N/A | N/A | Y | Y | Y | 3.00 | |
| 1510 | 3 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1540 | 3 | Tac Equip Shop | 95 | PW | N | | | | |
| 1720 | 2 | D.S. Maint Fac | 148 | DHW | Y | N-N/A | N | | |
| 1810 | 2 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1820 | 2 | Tac Equip Shop | N/A | N/A | Y | N-N/A | N | | |
| 1840 | 2 | Tac Equip Shop | N/A | N/A | Y | N | Y | | |
| 2115 | 1 | Dental Clinic | N/A | N/A | Y | N | N | | |
| 2125 | 1 | Chapel | 120 | DHW | Y | N | N | | |
| 3001 | S | S. Energy Plant | N/A | N/A | Y | Y | | | |
| 3002 | S | Admin. | N/A | N/A | Y | Y | N | 5.20 | |
| 4502 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4528 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4577 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4578 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| TOTALS | | 140 | | | 127 | 42 | 41 | 55.11 Drop/Sec | 11.80 Cup/Min |

| | | |
|---|---|---|
| Leaks (GPM) = | 0.138 | 0.737 |
| % of Total = | 16% | 84% |
| Total Leaks = | 0.875 GPM | |

ECO-5

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Leaks in Mechanical Rooms
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 5

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-5.WQ1

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Travel time to bldgs. | 7.0 | hr | | 0 | 30.3 | 212 | 212 | | (1) |
| Repair/tighten valves | 4.5 | hr | | 0 | 30.3 | 136 | 136 | | (2) |
| Repair/tighten flanges | 2.3 | hr | | 0 | 30.3 | 71 | 71 | | (3) |
| Remove valves (4) | 9 | Ea | | 0 | 52.8 | 475 | 475 | | MMp191 |
| 2" gate valve, 250 lb (4) | 9 | Ea | 256 | 2304 | 52.8 | 475 | 2,779 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 2304 | | 1369 | $3,673 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 2304 | | 1369 | 3,673 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -605 | (605) | MMp533 | MMp533 |
| Subtotal | | | | 2304 | | 764 | 3,068 | | |
| OH & Profit Markups | | | 10% | 230 | 53% | 405 | 635 | MMp7 | MMp475 |
| Subtotal | | | | 2534 | | 1169 | 3,703 | | |
| Sales Taxes | | | 4.0% | 101 | | NA | 101 | MMp476 | |
| Total Construction Cost | | | | 2635 | | 1169 | 3,804 | | |
| Design Fee | | | | NA | 6.0% | 228 | 228 | | |
| SIOH | | | | NA | 6.0% | 228 | 228 | | |
| Subtotal | | | | 2635 | | 1625 | 4,260 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 2635 | | 1625 | $4,260 | | |

LEGEND:
(1) Estimate 10 minutes per building for 42 buildings.
(2) Estimate 10 minutes per valve for 27 valves (also see note 4).
(3) Estimate 10 minutes per flange for 14 flanges.
(4) Assumes 25 % of the 36 leaking valves will be replaced.
MMp### 1996 Means Mechanical Cost Data, page ###.

# Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

6.2-16

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-6 Repair building side DHW and HVAC hot water leaks.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 1

DESCRIPTION OF WORK

## ECO Number 6

Repair building side DHW and HVAC hot water leaks.

**Description**

This project involves tightening connections to valves and fittings on domestic hot water (DHW) and heating hot water (HHW) pipes within the mechanical equipment rooms served by the HTW system. There are also 11 relief valves that are passing water and should be replaced.

The survey of the mechanical equipment rooms revealed leaking valves and fittings in 26 of the 127 rooms surveyed. There were leaking circulating pumps, leaking relief valves, leaking drain valves and leaking pipe fittings. The location of the leaks is contained in Attachment 3. The total estimated hot water losses from valves and fittings within the mechanical equipment rooms are 1.9 GPM (2,740 GPD). The energy savings calculations assume that all eight of the major leaks and about 50 percent of the 21 minor leaks can be repaired. Approximately 2,620 GPD of the DHW and HHW leaks in the mechanical equipment rooms would be eliminated.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-6

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-6
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-6 REPAIR DHW AND HHW LEAKS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 1448. | | |
| B. SIOH | $ 87. | | |
| C. DESIGN COST | $ 87. | | |
| D. TOTAL COST (1A+1B+1C) | $ 1622. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 1622. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1111. | $ 1489. | 14.88 | $ 22152. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1111. | $ 1489. | | $ 22152. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 530.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7886.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7886.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2019.

5. SIMPLE PAYBACK PERIOD (1G/4) .80 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 30039.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 18.52
(IF < 1 PROJECT DOES NOT QUALIFY)

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

Eco-6

Location: Fort Stewart, GA
AEP Number: 694-1331-002
Project: Repair DHW and HHW Leaks
ECO Number: 6

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/08/96

Assumptions:
1. HHW temperature 180 °F
2. Make-up water temperature 70 °F
3. Condensate temperature 200 °F
4. Boiler efficiency 68%
5. Average heating fuel cost $1.34 /MBtu
6. Water cost $0.5562 /kGallons

| Bldg. | Leak | Location | Cup/Min | Drop/Sec | GPM | Temp.,°F | MBtu/Yr | |
|---|---|---|---|---|---|---|---|---|
| 218 | DHW | from circ. pump | 1.0 | | 0.0625 | 124 | 14.8 | |
| 512 | COND | from T at cond. tank | | 10.0 | 0.0250 | 200 | 14.2 | |
| 515 | DHW | from circ. pump | | 1.0 | 0.0025 | 123 | 0.6 | |
| 516 | DHW | from relief valve | 6.0 | | 0.3750 | 125 | 90.4 | |
| 518 | DHW | from relief valve | 3.5 | | 0.2188 | 183 | 108.4 | |
| 624 | COND | from near cond. tank | | 12.0 | 0.0300 | 200 | 17.1 | |
| 629 | HHW | from relief valve | 6.0 | | 0.3750 | 211 | 231.8 | |
| 630 | HHW | from relief valve | | 0.2 | 0.0005 | 180 | 0.2 | |
| 630 | HHW | from air separator | | 0.4 | 0.0010 | 180 | 0.5 | |
| 631 | HHW | supply side of ht ex | | 1.0 | 0.0025 | 180 | 1.2 | |
| 633 | HHW | from relief valve | | 1.0 | 0.0025 | 180 | 1.2 | |
| 636 | DHW | from HWG drain pipe | | 15.0 | 0.0375 | 138 | 11.2 | |
| 638 | HHW | from circ. pump | | 0.3 | 0.0008 | 180 | 0.4 | |
| 642 | DHW | from pipe above tank | | 5.0 | 0.0125 | 154 | 4.6 | |
| 644 | HHW | from relief valve | 1.1 | | 0.0703 | 180 | 33.9 | |
| 648 | HHW | from relief valve | | 1.0 | 0.0025 | 180 | 1.2 | |
| 706 | HHW | from circ. pump | | 3.0 | 0.0075 | 180 | 3.6 | |
| 708 | HHW | from relief valve | | 5.0 | 0.0125 | 180 | 6.0 | |
| 708 | DHW | from relief valve | 1.0 | | 0.0625 | 131 | 16.7 | |
| 722 | HHW | from circ. pump | | 2.0 | 0.0050 | 200 | 2.8 | |
| 726 | COND | at cond. tank | | 1.0 | 0.0025 | 200 | 1.4 | |
| 726 | DHW | from circ. pump | | 5.0 | 0.0125 | 158 | 4.8 | |
| 814 | HHW | from circ. pump | | 3.0 | 0.0075 | 180 | 3.6 | |
| 816 | HHW | from drain valve | | 0.1 | 0.0003 | 180 | 0.1 | |
| 1208 | HHW | from drain valve | | 0.2 | 0.0005 | 180 | 0.2 | |
| 1245 | HHW | from circ. pump | | 1.0 | 0.0025 | 180 | 1.2 | |
| 1280 | HHW | from relief valve | 7.0 | | 0.4375 | 150 | 153.4 | |
| 1509 | HHW | from relief valve | 2.1 | | 0.1328 | 180 | 64.0 | |
| 1840 | HHW | from circ. pump | | 1.0 | 0.0025 | 180 | 1.2 | |
| 29 | Current HTW Losses | | 27.8 | 68.2 | 1.9049 | GPM | 791.0 | MBtu/Yr |
| | | | x 1.00 | x 0.50 | | | | |
| | Proposed HTW Savings | | 27.8 | 34.1 | 1.8196 | GPM | 755.6 | MBtu/Yr |
| | Proposed HTW Losses | | | | 0.0853 | GPM | 35.4 | MBtu/Yr |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

Current Fuel Use = 791.0 MBtu/yr / 0.68 = 1163.2 MBtu/Yr
Current Fuel Cost = 1163.2 MBtu/yr x $1.34 /MBtu = $1,559 /Year

New Fuel Use = 35.4 MBtu/yr / 0.68 = 52.1 MBtu/Yr
New Fuel Cost = 52.1 MBtu/yr x $1.34 /MBtu = $70 /Year

Water Cost:

Current water cost = 1001224 Gal/Yr x $0.5562 /kGal = $557 /Year
New water cost = 44818 Gal/Yr x $0.5562 /kGal = $25 /Year

ECO-6

# CONSTRUCTION COST ESTIMATE

Project: Repair DHW and HHW Leaks in Mechanical Rooms
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 6

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-6.WQ1

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Travel time to bldgs. | 4.3 | hr | | 0 | 30.3 | 131 | 131 | | (1) |
| Repair/tighten fittings | 6.0 | hr | | 0 | 30.3 | 182 | 182 | | (2) |
| Remove P&T valves | 11 | Ea | | 0 | 10 | 110 | 110 | | MMp188 |
| 1" P & T relief valve | 11 | Ea | 79 | 869 | 10 | 110 | 979 | MMp188 | MMp188 |
| Subtotal Bare Costs | | | | 869 | | 533 | $1,402 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 869 | | 533 | 1,402 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -236 | (236) | MMp533 | MMp533 |
| Subtotal | | | | 869 | | 297 | 1,166 | | |
| OH & Profit Markups | | | 10% | 87 | 53% | 157 | 244 | MMp7 | MMp475 |
| Subtotal | | | | 956 | | 454 | 1,410 | | |
| Sales Taxes | | | 4.0% | 38 | | NA | 38 | MMp476 | |
| Total Construction Cost | | | | 994 | | 454 | 1,448 | | |
| Design Fee | | | | NA | 6.0% | 87 | 87 | | |
| SIOH | | | | NA | 6.0% | 87 | 87 | | |
| Subtotal | | | | 994 | | 628 | 1,622 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 994 | | 628 | $1,622 | | |

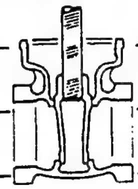
LEGEND:
- (1) Estimate 10 minutes per building for 26 buildings.
- (2) Estimate 20 minutes per fitting for 18 fittings.
- MMp### 1996 Means Mechanical Cost Data, page ###.

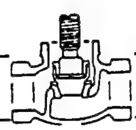
Eco-6



## 151 950 | Valves

R151 -090





| | | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3420 | 3/8" size | 1 Plum | 24 | .333 | Ea. | 18.50 | 10 | | 28.50 | 36 | 955 |
| 3430 | 1/2" size | | 24 | .333 | | 16.65 | 10 | | 26.65 | 33.50 | |
| 3440 | 3/4" size | | 20 | .400 | | 19.80 | 12 | | 31.80 | 40.50 | |
| 3450 | 1" size | | 19 | .421 | | 26 | 12.65 | | 38.65 | 48 | |
| 3460 | 1-1/4" size | | 15 | .533 | | 35 | 16.05 | | 51.05 | 63 | |
| 3470 | 1-1/2" size | | 13 | .615 | | 43 | 18.50 | | 61.50 | 76 | |
| 3480 | 2" size | | 11 | .727 | | 59.50 | 22 | | 81.50 | 99 | |
| 3490 | 2-1/2" size | Q-1 | 15 | 1.067 | | 138 | 29 | | 167 | 196 | |
| 3500 | 3" size | • | 13 | 1.231 | | 195 | 33.50 | | 228.50 | 266 | |
| 3850 | Rising stem, soldered, 300 psi | | | | | | | | | | |
| 3900 | 3/8" size | 1 Plum | 24 | .333 | Ea. | 25 | 10 | | 35 | 43 | |
| 3920 | 1/2" size | | 24 | .333 | | 29 | 10 | | 39 | 47.50 | |
| 3940 | 3/4" size | | 20 | .400 | | 37.50 | 12 | | 49.50 | 60 | |
| 3950 | 1" size | | 19 | .421 | | 41 | 12.65 | | 53.65 | 65 | |
| 3960 | 1-1/4" size | | 15 | .533 | | 69 | 16.05 | | 85.05 | 100 | |
| 3970 | 1-1/2" size | | 13 | .615 | | 78.50 | 18.50 | | 97 | 115 | |
| 3980 | 2" size | | 11 | .727 | | 110 | 22 | | 132 | 155 | |
| 3990 | 2-1/2" size | Q-1 | 15 | 1.067 | | 251 | 29 | | 280 | 320 | |
| 4000 | 3" size | • | 13 | 1.231 | | 350 | 33.50 | | 383.50 | 435 | |
| 4250 | Threaded, class 150 | | | | | | | | | | |
| 4310 | 1/4" size | 1 Plum | 24 | .333 | Ea. | 16.85 | 10 | | 26.85 | 34 | |
| 4320 | 3/8" size | | 24 | .333 | | 16.85 | 10 | | 26.85 | 34 | |
| 4330 | 1/2" size | | 24 | .333 | | 16 | 10 | | 26 | 33 | |
| 4340 | 3/4" size | | 20 | .400 | | 19.10 | 12 | | 31.10 | 39.50 | |
| 4350 | 1" size | | 19 | .421 | | 25 | 12.65 | | 37.65 | 47 | |
| 4360 | 1-1/4" size | | 15 | .533 | | 34 | 16.05 | | 50.05 | 62 | |
| 4370 | 1-1/2" size | | 13 | .615 | | 41.50 | 18.50 | | 60 | 74 | |
| 4380 | 2" size | | 11 | .727 | | 57.50 | 22 | | 79.50 | 97 | |
| 4390 | 2-1/2" size | Q-1 | 15 | 1.067 | | 133 | 29 | | 162 | 190 | |
| 4400 | 3" size | • | 13 | 1.231 | | 187 | 33.50 | | 220.50 | 257 | |
| 4500 | For 300 psi, threaded, add | | | | | 100% | 15% | | | | |
| 4540 | For chain operated type, add | | | | | 15% | | | | | |
| 4850 | Globe, class 150, rising stem, threaded | | | | | | | | | | |
| 4920 | 1/4" size | 1 Plum | 24 | .333 | Ea. | 23.50 | 10 | | 33.50 | 41.50 | |
| 4940 | 3/8" size | | 24 | .333 | | 23.50 | 10 | | 33.50 | 41.50 | |
| 4950 | 1/2" size | | 24 | .333 | | 23.50 | 10 | | 33.50 | 41.50 | |
| 4960 | 3/4" size | | 20 | .400 | | 32 | 12 | | 44 | 53.50 | |
| 4970 | 1" size | | 19 | .421 | | 50 | 12.65 | | 62.65 | 74.50 | |
| 4980 | 1-1/4" size | | 15 | .533 | | 78.50 | 16.05 | | 94.55 | 111 | |
| 4990 | 1-1/2" size | | 13 | .615 | | 94.50 | 18.50 | | 113 | 133 | |
| 5000 | 2" size | | 11 | .727 | | 143 | 22 | | 165 | 191 | |
| 5010 | 2-1/2" size | Q-1 | 15 | 1.067 | | 287 | 29 | | 316 | 360 | |
| 5020 | 3" size | • | 13 | 1.231 | | 410 | 33.50 | | 443.50 | 500 | |
| 5120 | For class 300, threaded, add | | | | | 50% | 15% | | | | |
| 5130 | Globe, 300 lb., sweat, 3/8" size | 1 Plum | 24 | .333 | | 26 | 10 | | 36 | 44 | |
| 5140 | 1/2" size | | 24 | .333 | | 26 | 10 | | 36 | 44 | |
| 5150 | 3/4" size | | 20 | .400 | | 38 | 12 | | 50 | 60.50 | |
| 5160 | 1" size | | 19 | .421 | | 57 | 12.65 | | 69.65 | 82 | |
| 5170 | 1-1/4" size | | 15 | .533 | | 87 | 16.05 | | 103.05 | 120 | |
| 5180 | 1-1/2" size | | 13 | .615 | | 104 | 18.50 | | 122.50 | 143 | |
| 5190 | 2" size | | 11 | .727 | | 157 | 22 | | 179 | 207 | |
| 5200 | 2-1/2" size | Q-1 | 15 | 1.067 | | 345 | 29 | | 374 | 425 | |
| 5210 | 3" size | • | 13 | 1.231 | | 505 | 33.50 | | 538.50 | 605 | |
| 5600 | Relief, pressure & temperature, self-closing, ASME | | | | | | | | | | |
| 5640 | 3/4" size | 1 Plum | 28 | .286 | Ea. | 51.50 | 8.60 | | 60.10 | 69.50 | |
| 5650 | 1" size | | 24 | .333 | | 79 | 10 | | 89 | 102 | |





6 3-9

ECO-6

# Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

## Project Number and Title

ECO-7 Repair HTW leaks in valve pits, drain pits and valve boxes.

## Project Funding Category

Federal Energy Management Program (FEMP)

## Contents

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 1

DESCRIPTION OF WORK

## ECO Number 7

Repair HTW leaks in valve pits, drain pits and valve boxes.

**<u>Description</u>**

This project involves tightening the bolts on flanges and valve stems within the valve pits throughout the HTW system. There may also be some valves that must be replaced. The survey of the valve pits revealed leaking valves and flanges in 13 of the 95 pits surveyed. There were a total of nine leaking valves and five leaking flanges. The location of the leaks is contained in Attachment 3. The total estimated HTW losses from valves and fittings within the valve pits are 0.97 GPM (1,400 GPD). The energy savings calculations assume that all four of the major leaks and about 50 percent of the nine minor leaks can be repaired. Approximately 1,350 GPD of the HTW leaks in the valve pits would be eliminated. The cost estimate assumes that two of the leaking valves will be replaced.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-7

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-7
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 2480. | | |
| B. SIOH | $ 149. | | |
| C. DESIGN COST | $ 149. | | |
| D. TOTAL COST (1A+1B+1C) | $ 2778. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 2778. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 33. | 15.08 | $ 497. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1873. | $ 2510. | 14.88 | $ 37346. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1875. | $ 2543. | | $ 37843. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2818.

5. SIMPLE PAYBACK PERIOD (1G/4) .99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 41935.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.10
(IF < 1 PROJECT DOES NOT QUALIFY)

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

RS&H

SUBJECT FORT STEWART
REPAIR LEAKS IN VALVE PITS
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET ___ OF ___
DATE 2-8-96
DATE

ECO-7 SUMMARY

ANNUAL SAVINGS

ELECTRICITY = 2.5 - 0.1 = $\boxed{2.4 \text{ MBtu/YR}}$

HEATING FUELS = 1942 - 69 = $\boxed{1873 \text{ MBtu/YR}}$

WATER = \$284 - \$10 = $\boxed{\$274\text{/YR}}$

ECO-7

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in Valve Pits | Date: | 02/08/96 |
| ECO Number: | 7 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

510360 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1320.3 MBtu/Yr

Heating Fuel Use = 1320.3 MBtu/yr / 0.68 = 1941.6 MBtu/Yr

Heating Fuel Cost = 1941.6 MBtu/yr x $1.34 /MBtu = $2,602 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.97 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.10 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.10 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 742 kWh/Yr

Electricity Use = 742 kWh/Yr x 0.003413 MBtu/kWh = 2.5 MBtu/Yr

Electricity Cost = 742 kWh/Yr x $0.0469 /kWh = $35 /Year

Water Cost:

510360 Gal/Yr x $0.5562 /kGal = $284 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,602 | /Year |
| Pumping (Elec) Cost | $35 | /Year |
| Water Cost | $284 | /Year |
| Total Utility Cost | $2,921 | /Year |

ECO-7

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in Valve Pits | Date: | 02/08/96 |
| ECO Number: | 7 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

18130 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 46.9 MBtu/Yr

Heating Fuel Use = 46.9 MBtu/yr / 0.68 = 69.0 MBtu/Yr

Heating Fuel Cost = 69.0 MBtu/yr x $1.34 /MBtu = $92 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.00 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.00 BHP / 0.90 x 0.746 kW/HP = 0.00 kW

Electricity Use = 0.00 kW x 8760 Hr/Yr = 26 kWh/Yr

Electricity Use = 26 kWh/Yr x 0.003413 MBtu/kWh = 0.1 MBtu/Yr

Electricity Cost = 26 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

18130 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $92 | /Year |
| Pumping (Elec) Cost | $1 | /Year |
| Water Cost | $10 | /Year |
| Total Utility Cost | $103 | /Year |

RS&H

SUBJECT Fort Stewart
Repair Leaks in Valve Pits
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ___ OF ___
DATE 2-5-96
DATE

| Valve Pit No. / Near | Drops / Sec | Stream Dia. / GPM | Leak From |
|---|---|---|---|
| VP-1-11 / 704 | 1/3 | – – | Valve |
| VP-1-16 / 726 | 3+2 | – – | ↓ |
| VP-2N-5 / 1820 | 5+ | – – | ↓ |
| VP-2S-1 / 6th St. | 2 | – – | ↓ |
| VP-2S-3 / 517 | 2 | – – | ↓ |
| VP-2S-8 / 512 | 2+2 | – – | 2 valves |
| VP-3-1 / 1540 | 2 | 1/4" / 0.438 | Flange |
| VP-3-5 / 1170 | 1/10 + 2 | – – | Valve |
| VP-3-11 / 419 | – | 1/8" / 0.109 | " |
| VP-3-15 / 200 blk Field | – | 1/8" / 0.109 | Flange |
| VP-3-16 / 225 | – | 3/16" / 0.246 | ↓ |
| VP-3-18 / 218 | 2 | – – | ↓ |
| VP-3-27 / 213 | 1+2 | – – | ↓ |
| Totals 13 Pits | 27.4 D/s | 0.902 GPM | |

Minor Leaks:

$$27.4 \ \text{drop/s} \times 2.5\times10^{-3} \ \frac{\text{GPM}}{\text{d/s}} = 0.069 \ \text{GPM} = 36{,}270 \ \frac{\text{GAL}}{\text{YR}}$$

Proposed HTW losses: Assume 50% of minor leaks

$$0.069 \ \text{GPM} \times 1440 \ \frac{\text{min}}{\text{day}} \times 365 \ \frac{\text{day}}{\text{YR}} \times 0.5 = \underline{18130 \ \frac{\text{GAL}}{\text{YR}}}$$

Major Leaks: (Assume 100% can be repaired)

$$0.902 \ \text{GPM} \times 1440 \ \text{min/day} \times 365 \ \text{day/YR} = 474{,}090 \ \text{GAL/YR}$$

Current HTW Losses:

$$474090 \ \text{GAL/YR} + 36270 \ \text{GAL/YR} = \underline{510{,}360 \ \text{GAL/YR}}$$

ECO-7

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Leaks in Valve Pits
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 7

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-7.WQ1

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Travel time to bldgs. | 2.2 | hr | | 0 | 30.3 | 66 | 66 | | (1) |
| Repair/tighten valves | 1.8 | hr | | 0 | 30.3 | 53 | 53 | | (2) |
| Repair/tighten flanges | 1.3 | hr | | 0 | 30.3 | 38 | 38 | | (3) |
| Remove valves (4) | 2 | Ea | | 0 | 217.8 | 436 | 436 | | MMp191 |
| 6" gate valve, 250 lb (4) | 2 | Ea | 700 | 1400 | 217.8 | 436 | 1,836 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 1400 | | 1029 | $2,429 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 1400 | | 1029 | 2,429 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -455 | (455) | MMp533 | MMp533 |
| Subtotal | | | | 1400 | | 574 | 1,974 | | |
| OH & Profit Markups | | | 10% | 140 | 53% | 304 | 444 | MMp7 | MMp475 |
| Subtotal | | | | 1540 | | 878 | 2,418 | | |
| Sales Taxes | | | 4.0% | 62 | | NA | 62 | MMp476 | |
| Total Construction Cost | | | | 1602 | | 878 | 2,480 | | |
| Design Fee | | | | NA | 6.0% | 149 | 149 | | |
| SIOH | | | | NA | 6.0% | 149 | 149 | | |
| Subtotal | | | | 1602 | | 1176 | 2,778 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 1602 | | 1176 | $2,778 | | |

LEGEND:

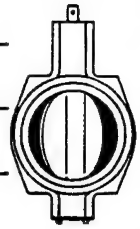
(1) Estimate 10 minutes per valve pit for 13 valve pits.
(2) Estimate 15 minutes per valve for 7 valves (also see note 4).
(3) Estimate 15 minutes per flange for 5 flanges.
(4) Assumes 25 % of the 9 leaking valves will be replaced.
MMp### 1996 Means Mechanical Cost Data, page ###.

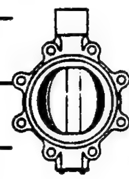
ECO-7



## 151 950 | Valves

| | | | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 960 | 1050 | 3" size R151-090 | Q-1 | 8 | 2 | Ea. | 175 | 54 | | 229 | 276 |
| | 1060 | 4" size | ↓ | 5 | 3.200 | | 215 | 86.50 | | 301.50 | 370 |
| | 1070 | 5" size | Q-2 | 5 | 4.800 | | 250 | 135 | | 385 | 480 |
| | 1080 | 6" size | | 5 | 4.800 | | 273 | 135 | | 408 | 505 |
| | 1090 | 8" size | | 4.50 | 5.333 | | 360 | 150 | | 510 | 625 |
| | 1100 | 10" size | | 4 | 6 | | 415 | 168 | | 583 | 715 |
| | 1110 | 12" size | ↓ | 3 | 8 | ↓ | 570 | 224 | | 794 | 970 |
| | 1200 | Lug type, lever actuator | | | | | | | | | |
| | 1220 | 2" size | 1 Plum | 14 | .571 | Ea. | 87 | 17.15 | | 104.15 | 122 |
| | 1230 | 2-1/2" size | Q-1 | 9 | 1.778 | | 89 | 48 | | 137 | 172 |
| | 1240 | 3" size | | 8 | 2 | | 95 | 54 | | 149 | 188 |
| | 1250 | 4" size | ↓ | 5 | 3.200 | | 121 | 86.50 | | 207.50 | 265 |
| | 1260 | 5" size | Q-2 | 5 | 4.800 | | 175 | 135 | | 310 | 400 |
| | 1270 | 6" size | | 5 | 4.800 | | 197 | 135 | | 332 | 425 |
| | 1280 | 8" size | | 4.50 | 5.333 | | 281 | 150 | | 431 | 540 |
| | 1290 | 10" size | | 4 | 6 | | 390 | 168 | | 558 | 690 |
| | 1300 | 12" size | ↓ | 3 | 8 | | 595 | 224 | | 819 | 1,000 |
| | 1320 | For gear actuator, add | | | | ↓ | 60% | | | | |
| | 1400 | Diverter, 150 lb. flanged, bronze or iron plugs | | | | | | | | | |
| | 1440 | 2" pipe size | Q-1 | 2 | 8 | Ea. | 2,475 | 216 | | 2,691 | 3,050 |
| | 1450 | 3" pipe size | " | 1.50 | 10.667 | " | 3,550 | 289 | | 3,839 | 4,350 |
| | 1650 | Gate, 125 lb., N.R.S., | | | | | | | | | |
| | 2150 | Flanged | | | | | | | | | |
| | 2200 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 252 | 48 | | 300 | 350 |
| | 2240 | 2-1/2" size | Q-1 | 5 | 3.200 | | 258 | 86.50 | | 344.50 | 415 |
| | 2260 | 3" size | | 4.50 | 3.556 | | 290 | 96 | | 386 | 465 |
| | 2280 | 4" size | ↓ | 3 | 5.333 | | 415 | 144 | | 559 | 675 |
| | 2290 | 5" size | Q-2 | 3.40 | 7.059 | | 705 | 198 | | 903 | 1,075 |
| | 2300 | 6" size | | 3 | 8 | | 705 | 224 | | 929 | 1,125 |
| | 2320 | 8" size | | 2.50 | 9.600 | | 1,225 | 269 | | 1,494 | 1,750 |
| | 2340 | 10" size | | 2.20 | 10.909 | | 2,150 | 305 | | 2,455 | 2,850 |
| | 2360 | 12" size | | 1.70 | 14.118 | | 2,950 | 395 | | 3,345 | 3,850 |
| | 2370 | 14" size | | 1.30 | 18.462 | | 3,575 | 520 | | 4,095 | 4,725 |
| | 2380 | 16" size | ↓ | 1 | 24 | | 5,225 | 675 | | 5,900 | 6,775 |
| | 2420 | For 250 lb., flanged, add | | | | ↓ | 200% | 10% | | | |
| | 3550 | OS&Y, flanged | | | | | | | | | |
| | 3600 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 128 | 48 | | 176 | 215 |
| | 3640 | 2-1/2" size | Q-1 | 5 | 3.200 | | 132 | 86.50 | | 218.50 | 277 |
| | 3660 | 3" size | | 4.50 | 3.556 | | 149 | 96 | | 245 | 310 |
| | 3670 | 3-1/2" size | | 3 | 5.333 | | 212 | 144 | | 356 | 455 |
| | 3680 | 4" size | ↓ | 3 | 5.333 | | 212 | 144 | | 356 | 455 |
| | 3690 | 5" size | Q-2 | 3.40 | 7.059 | | 350 | 198 | | 548 | 690 |
| | 3700 | 6" size | | 3 | 8 | | 350 | 224 | | 574 | 730 |
| | 3720 | 8" size | | 2.50 | 9.600 | | 625 | 269 | | 894 | 1,100 |
| | 3740 | 10" size | | 2.20 | 10.909 | | 1,150 | 305 | | 1,455 | 1,750 |
| | 3760 | 12" size | | 1.70 | 14.118 | | 1,525 | 395 | | 1,920 | 2,275 |
| | 3770 | 14" size | | 1.30 | 18.462 | | 2,950 | 520 | | 3,470 | 4,050 |
| | 3780 | 16" size | | 1 | 24 | | 4,575 | 675 | | 5,250 | 6,050 |
| | 3790 | 18" size | | .80 | 30 | | 6,125 | 840 | | 6,965 | 8,050 |
| | 3800 | 20" size | | .60 | 40 | | 8,550 | 1,125 | | 9,675 | 11,100 |
| | 3830 | 24" size | ↓ | .50 | 48 | | 12,700 | 1,350 | | 14,050 | 16,100 |
| | 3900 | For 250 lb flanged, add | | | | ↓ | 200% | 10% | | | |
| | 4350 | Globe, OS&Y, | | | | | | | | | |
| | 4540 | Class 125, flanged | | | | | | | | | |
| | 4550 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 266 | 48 | | 314 | 365 |
| | 4560 | 2-1/2" size | Q-1 | 5 | 3.200 | ↓ | 281 | 86.50 | | 367.50 | 440 |





MECHANICAL

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-10A Distribute HTW to the SEP instead of steam.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 1

DESCRIPTION OF WORK

## ECO Number 10

Use an alternative heating method to reduce SEP operating cost.

**Option A. Distribute HTW to the SEP Instead of Steam**

**Description - Option A**

This project option involves the installation of piping and connections to the CEP as required to supply the SEP with HTW from the CEP. The two phase fluid operation would be eliminated and a significant savings in operation and maintenance costs would result.

A major difficulty in operating and maintaining the SEP during the heating season arises from its two phase fluid operation. Current operational problems include assuring proper warm-up of the steam supply line, conserving the resulting condensate, properly warming-up and operating the SEP equipment and its distribution system and maintaining the proper water level in the SEP cascade heaters. Without any automatic controls, this a challenging effort requiring constant visits by operators.

HTW from the CEP can be sent directly to the SEP without any piping revisions outside the CEP. The SEP steam line would be separated from the CEP steam header and blanking plates installed. A four- inch diameter line would be installed connecting the CEP cascade heater discharge header to the SEP "steam" supply line. HTW would then flow directly from the CEP to the SEP. The SEP could be configured, through use of existing valves, to accept HTW, circulate it through its existing distribution system and pump it back to the CEP cascade heaters.

Steam trap isolation valves for the condensate drain system servicing the CEP to SEP "steam" line should be cracked open to protect the condensate line from freezing.

The HTW return valves at the SEP cascade heaters will be closed and the HTW return pumps at the SEP will operate continuously. With the HTW return valves at the cascade heaters closed, there will be enough head pressure to circulate the necessary water between the CEP and the SEP because the circulating pumps and the return pumps will be operating in tandem.

This operating configuration may not be satisfactory if the heating load on the SEP is substantially increased due to the addition of processes or buildings. Should the SEP heating load increase in the future, this operating technique will have to be reassessed. Changing back to steam operation sometime in the future would simply require the removal of the blanking plates from the steam lines, and the installation of new blanking plates in the HTW line at the CEP.

There would be no change in thermal losses from the distribution system because there would be no change in system operating temperature. However, the SEP condensate dumping during start-up would be eliminated and there would be a reduction in start up and operating labor for the SEP.

The HTW jumper line in the CEP should be installed during the non-heating season. Operators should practice starting up the SEP on HTW before the following heating season begins.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-10A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: ECO-10
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 6043. | | |
| B. SIOH | $ 363. | | |
| C. DESIGN COST | $ 363. | | |
| D. TOTAL COST (1A+1B+1C) | $ 6769. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 6769. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 111. | $ 149. | 14.88 | $ 2213. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 111. | $ 153. | | $ 2275. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10102.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 150318.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 150318.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 10255.

5. SIMPLE PAYBACK PERIOD (1G/4) .66 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 152593.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 22.54
(IF < 1 PROJECT DOES NOT QUALIFY)

*** Project does not qualify for ECIP funding; 4,5,6 for information only.

6.5-6

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

RS&H

SUBJECT Fort Stewart
Send HTW from CEP to SEP
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET OF
DATE 2-7-96
DATE

ECO No. 10 - A DISTRIBUTE HTW FROM CEP TO SEP INSTEAD OF STEAM.

THE HTW SYSTEM OPERATES AT THE SAME TEMPERATURE AS THE STEAM LINE, 375 °F. IF THE STEAM LINE WERE USED TO CONVEY HTW TO THE SEP THE HEAT LOSS FROM THE LINE WOULDN'T CHANGE. THEREFORE THERE WOULD BE NO ENERGY SAVINGS, BUT THERE WOULD BE A SIGNIFICANT DECREASE IN HEATING SEASON OPERATING LABOR.

ENERGY LOSS IN STEAM LINE

ENERGY LOSS DATA FROM SEP TEST SHOWS 3.66 MBTU/HR IN 8750 FT OF PIPE. See calculation in ECO-12.

$$\text{STEAM LINE LOSS} = 3.66\ \text{MBTU/HR} \times \frac{5280\ \text{ft}}{8760\ \text{ft}} = 2.2\ \text{MBTU/HR}$$

MAX ENERGY REQ'T TO SEP

SEP LOAD = 25.46 MBTU/HR
LINE LOSS TO SEP = 2.2 MBTU/HR
TOTAL ENERGY REQ'T. 27.66 MBTU/HR.

JUMPER LINE SIZE IN CEP

$$\frac{27.66\ \text{MBTU/HR}}{500\ \frac{\text{PPH}}{\text{gpm}} \times (375-230)} = 382\ \text{gpm} \Rightarrow 4''\ \phi\ \text{PIPE.}$$

RETURN LINE ΔP

@ 382 gpm ΔP IN 4" LINE = 8ft/100 FT PIPE. (WORSED CASE)

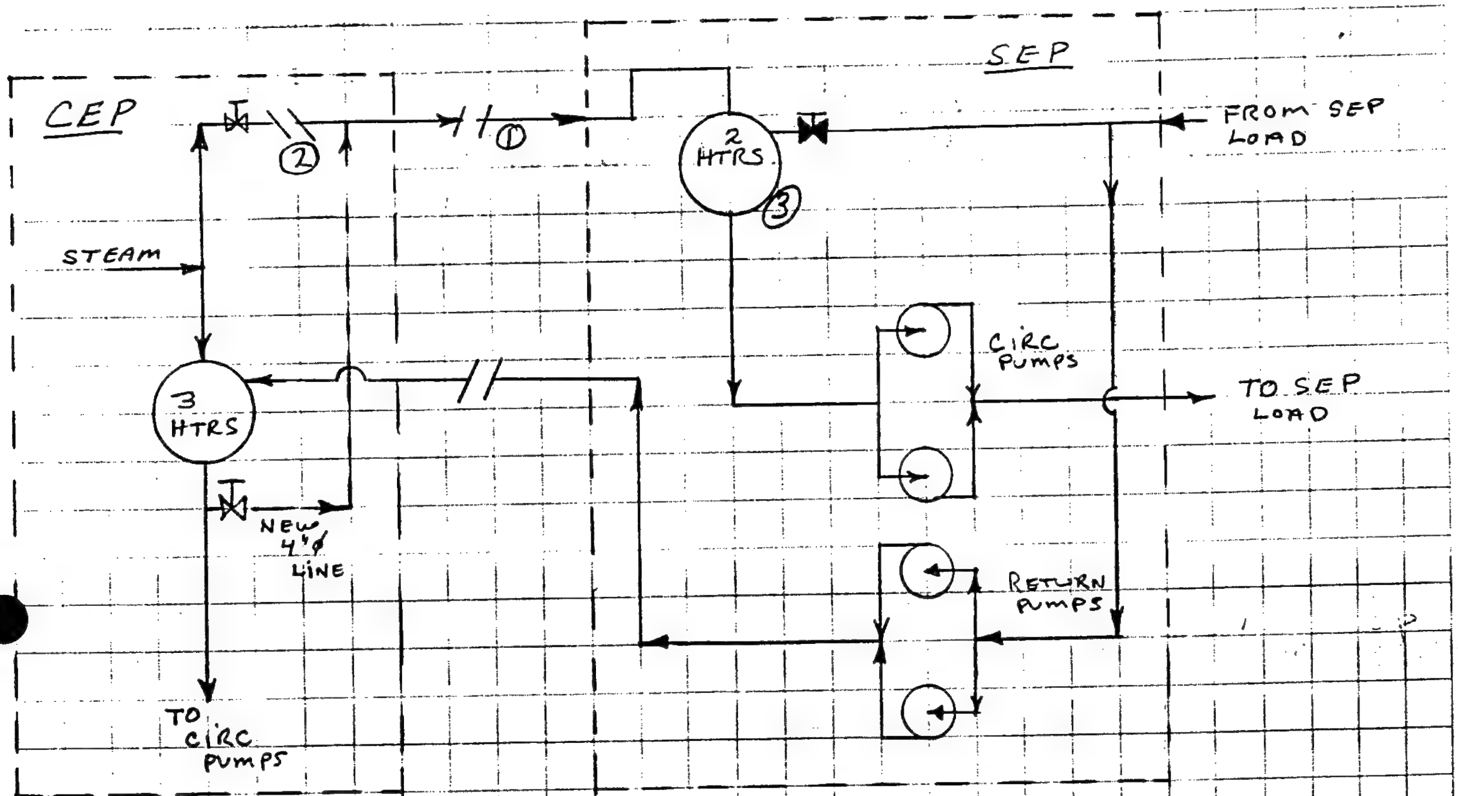
$$\frac{8\ \text{FT}}{100\ \text{FT}} \times 5280\ \text{FT} = 422\ \text{FT}$$

RS&H

SUBJECT Fort Stewart
HTW From CEP to SEP
DESIGNER G. Fallon
CHECKER
AEP NO 694 1331 002
SHEET OF
DATE 2-7-96
DATE

ECO-10-A

## Schematic Diagram




① DISCONNECT STEAM TRAPS; OR, HEAVILY THROTTLE TRAP ISOLATION VALVES TO MINIMIZE, BUT NOT STOP, FLOW THROUGH TRAPS. MINIMAL TRAP FLOW WILL PROTECT DRIP LINE FROM FREEZING.

② BREAK & BLANK EXISTING STEAM LINE AT HEADER.

③ OPERATE HEATERS FULL

**Proposed Labor Costs:**

Start-up & shut down: assume 50%; $(\$2069+\$621)/YR \times 0.5 = \$1345/YR$ (see next page)

Operating Labor Costs $= 1 \frac{trip}{day} \times \frac{1}{2} \frac{hr}{trip} \times \$25.86/hr \times 135 \frac{day}{yr} = \$1746/YR$

O&M Savings $= \$10473/YR - \$1746/YR + \$1345/YR = \boxed{\$10,072/YR}$

**RS&H**

SUBJECT: FORT STEWART
DESIGNER: W. Todd
CHECKER:
AEP NO: 694 1331 002
SHEET ___ OF ___
DATE: 2-1-96
DATE:

ECO-10

## Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for $4\frac{1}{2}$ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator Full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35 mm p 475

Adjusted for Savannah GA = \$46.35 × 0.558 = \$25.86 MMp.533

Labor Costs:

Startup: $10 \frac{days}{yr} \times 8 \frac{hrs}{day} \times \$25.86/hr = \underline{\$2069/YR}$

Operation: $4.5 \frac{mo}{YR} \times 30 \frac{day}{mo} \times 3 \frac{hr}{day} \times \$25.86/hr = \underline{\$10473/YR}$

Shut down: $3 \frac{day}{YR} \times 8 \frac{hr}{day} \times \$25.86/hr = \underline{\$621/YR}$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \$13163/YR

ECO-10A

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Distribute HTW from the CEP to the SEP | Date: | 02/12/96 |
| ECO Number: | 10 | | |

Assumptions:

1. HTW temperature — 380 °F
2. Make-up water temperature — 70 °F
3. Boiler efficiency — 68%
4. Pump head (from record drawings) — 300 Ft H20
5. Pump efficiency (from record drawings — 72%
6. Motor efficiency — 90%
7. Average heating fuel cost — $1.34 /MBtu
8. Electricity cost — $0.0469 /kWh
9. Water cost — $0.5562 /kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x $1.34 /MBtu = $148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

58094 Gal/Yr x $0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

| | |
|---|---|
| Heating Fuel Cost | $148 /Year |
| Pumping (Elec) Cost | $4 /Year |
| Water Cost | $32 /Year |
| Total Utility Cost | $184 /Year |

ECO-10A

# CONSTRUCTION COST ESTIMATE

Project: Distribute HTW instead of steam to SEP
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 10A

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: G. W. Fallon
Filename: EST-10A.WB2

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Sch. 40 steel pipe, 4" | 100 | LF | 12.75 | 1275 | 12.79 | 1279 | 2,554 | MMp140 | MMp140 |
| Insul., 2" CalSil w/cover | 100 | LF | 6.75 | 675 | 3.58 | 358 | 1,033 | MMp236 | MMp236 |
| Flange, 300lb, weld nk | 4 | Ea | 25 | 100 | 48.75 | 195 | 295 | MMp165 | MMp165 |
| Sch. 40 elbow | 6 | Ea | 17.5 | 105 | 97 | 582 | 687 | MMp159 | MMp159 |
| Weldolet Connection, 4" | 2 | Ea | 46.75 | 94 | 72 | 144 | 238 | MMp163 | MMp163 |
| Gate Valve, 4", 300 lb | 1 | Ea | 1100 | 1100 | 32.50 | 33 | 1,133 | MMp197 | MMp197 |
| Subtotal Bare Costs | | | | 3349 | | 2591 | $5,940 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 3349 | | 2591 | 5,940 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -1145 | (1,145) | MMp533 | MMp533 |
| Subtotal | | | | 3349 | | 1446 | 4,795 | | |
| OH & Profit Markups | | | 10% | 335 | 53% | 766 | 1,101 | MMp7 | MMp475 |
| Subtotal | | | | 3684 | | 2212 | 5,896 | | |
| Sales Taxes | | | 4.0% | 147 | | NA | 147 | MMp476 | |
| Total Construction Cost | | | | 3831 | | 2212 | 6,043 | | |
| Design Fee | | | | NA | 6.0% | 363 | 363 | | |
| SIOH | | | | NA | 6.0% | 363 | 363 | | |
| Subtotal | | | | 3831 | | 2938 | 6,769 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 3831 | | 2938 | $6,769 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-10A



'S

| To →/ From ↓ | ΔP psi | psf | Pa | kPa | ΔP/L (psi/ 100 ft) | (Pa/ m) | (kPa/ m) | ΔP/ρ ft (1) | (J/ kg) | ΔP/ρL (ft/ 100 ft) | (milinch/ ft) | (J/ kg m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| psi | 1 | 144 | 6890 | 6.89 | — | — | — | — | — | — | — | — |
| psf | 0.00694 | 1 | 4.79 | 0.00479 | — | — | — | — | — | — | — | — |
| Pa | 0.000145 | 0.209 | 1 | 0.001 | — | — | — | — | — | — | — | — |
| kPa | 0.145 | 209 | 1000 | 1 | — | — | — | — | — | — | — | — |
| (psi/ 100 ft) | — | — | — | — | 1 | 226 | 0.226 | — | — | — | — | — |
| (Pa/ m) | — | — | — | — | 0.00442 | 1 | 0.001 | — | — | — | — | — |
| (KPa/ m) | — | — | — | — | 4.42 | 1000 | 1 | — | — | — | — | — |
| ft (1) | — | — | — | — | — | — | — | 1 | 3.00 | — | — | — |
| (J/ kg) | — | — | — | — | — | — | — | 0.344 | 1 | — | — | — |
| (ft/ 100 ft) | — | — | — | — | — | — | — | — | — | 1 | 120 | 0.0983 |
| (milinch/ ft) | — | — | — | — | | — | — | — | — | 0.00833 | 1 | 0.000819 |
| (J/ kg m) | — | — | — | — | — | — | — | — | — | 10.2 | 1220.7 | 1 |

(1) (ft-lb/lb) = ft

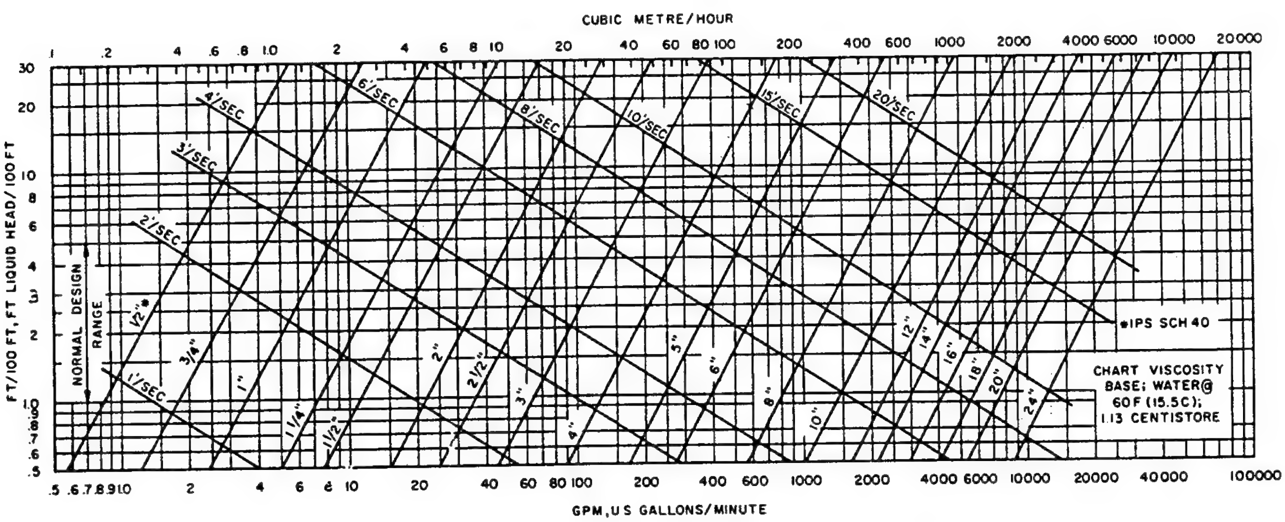



**Fig. 1 Friction Loss for Water in Commercial Steel Pipe (Schedule 40)**

system must be equipped with air separation devices to minimize the amount of entrained air in the piping circuit. Air should be vented at the highest point of the sytem.

In the absence of such venting, air can be entrained in the water and carried to separation units at flow velocities of 1.5 to 2 fps or more in pipe sizes 2 in. and under. Minimum velocities of 2 fps are therefore recommended. For pipe sizes 2 in. and over, minimum velocities corresponding to .75 ft/100 ft (.75 m/100 m) are normally used. Particular attention to maintenance of minimum velocities should be observed in the upper floors of high rise buildings when the air may tend to come out of solution because of the reduced pressures. Higher velocities should be used in *down-comer* return mains feeding into air separation units located in the basement.

*Example 1:* Determine pipe size for circuit requiring 20 gpm flow.
*Solution:* Enter Fig. 1 at 20 gpm, read up to pipe size within normal design range, select 1 1/2 in. Velocity is 3.1 fps which is between 2-4. Pressure loss is 2.9 ft/100 ft which is between 1-4 ft/100 ft.

## Valve and Fitting Pressure Drop

Valve and fitting pressure drop is usually listed in elbow equivalents. The elbow equivalent simply relates pressure drop through a valve or fitting to an equivalent pipe length. 2.7 The pressure drop of one elbow is approximately the same as that of a length of straight pipe 25 times the pipe diameter. The following simple rule-of-thumb is often used: the equivalent length of pipe in feet for an elbow equals 2 times nominal pipe diameter (inches). Thus, a 1-in. elbow = 2 equivalent ft of 1-in. pipe, a 4-in. elbow = 8 equivalent ft of 4-in. pipe, etc.

A more accurate determination, related to water flow velocity, is listed in Table 2.

Elbow equivalents for valves and fittings for iron and copper are shown in Table 3.

*Example 2*: Determine equivalent feet of pipe for a 4-in. open gate valve at a flow velocity of approximately 4 fps.
*Solution*: From Table 2, at 4 fps, each equivalent elbow is equal to 10.6 ft of 4-in. pipe. From Table 3, the 4-in. gate valve is equal to 0.5 elbows. The actual equivalent pipe length (added to measure circuit length for pressure drop determination) will be 10.6 × 0.5, or 5.3 equivalent feet of 4-in. pipe.

*Tee Fitting Pressure Drop.* Pressure drop through pipe tees varies with flow through the branch. Pressure drops are illustrated in Fig. 3 for tees of equal inlet and outlet sizes, and for the flow patterns illustrated.

6.5-13

ECO-10A

## Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

6.5-14

ECO-10A

# City Cost Indexes

| | DIVISION | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 | CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 | MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 | METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 | WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 | THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 | DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 | FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 | MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 | ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 | WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| | DIVISION | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| [illegible] | CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| [illegible] | MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| 5 | METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| 6 | WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 | DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 | FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 | MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 | ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 | WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| | DIVISION | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 | CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 | MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 | METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 | WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 | DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| [illegible] | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| 9 | FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 | MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 | ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 | WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

COST INDEXES

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-11 Use leak locator equipment to find major HTW leaks.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

# PROGRAMMING DOCUMENTATION - FEMP

## ATTACHMENT 1

## DESCRIPTION OF WORK

## ECO Number 11

Purchase leak locator equipment or contract leak locator service when a major HTW leak occurs.

**Description**

This project involves purchasing leak locator equipment or contracting with leak locator service to find HTW leaks so they can be repaired in a timely manner.

When a HTW leak occurs in the underground piping, steam and HTW flow forcibly from the conduit vents on both sides of the leak. To repair the leak, the maintenance staff isolates the section of pipe between valve pits and then they begin digging near the valve pit that is showing the most steam flow. This trial and error method can and usually does take numerous attempts before the leak is found. The maintenance staff expressed an interest in purchasing leak locating equipment but they did not know who manufactured this type of apparatus.

The leak location equipment includes two acoustical leak detectors that amplify the audio signals of the leaks and a microprocessor based leak locator. Each leak detector has a radio transmitter with a unique sound channel. Contact is established between the leak detector transducers and the HTW valves at two valve pits that flank a suspected leak. The radio transmitters send audio signals to the microprocessor based leak locator that is situated between the two valve pits.

Distribution information including pipe size, type and measured distance of pipe between the two valve pits are entered into the leak locator. Initialize the leak locator and the leak signals are processed by the computer. Leak position is shown and evaluated on a video display. The exact location of the leak and the distance from the valve pits to the leak are calculated. The amount of HTW escaping from each leak can be estimated by the audible signal of the leak detectors. The distance from the valve pit to the leak is then measured off and the location of the leak is marked.

The economics are marginal; however, if more than two leaks per year occur, the project economics will improve. This equipment can also be used to locate leaks in underground potable water and chilled water pipes.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-11

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-11
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 55500. | | |
| B. SIOH | $ 0. | | |
| C. DESIGN COST | $ 0. | | |
| D. TOTAL COST (1A+1B+1C) | $ 55500. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 55500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 1. | 15.08 | $ 21. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 76. | $ 102. | 14.88 | $ 1511. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 76. | $ 103. | | $ 1532. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 5658. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.88 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 84191. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5761.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.63 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85723.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)

*** Project does not qualify for ECIP funding; 4,5,6 for information only.

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

RS&H

SUBJECT Fort Stewart
Purchase Leak Correlator
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 1 OF
DATE 2-7-96
DATE Rev. 4-12-96

# ECO-11 PURCHASE LEAK CORRELATOR

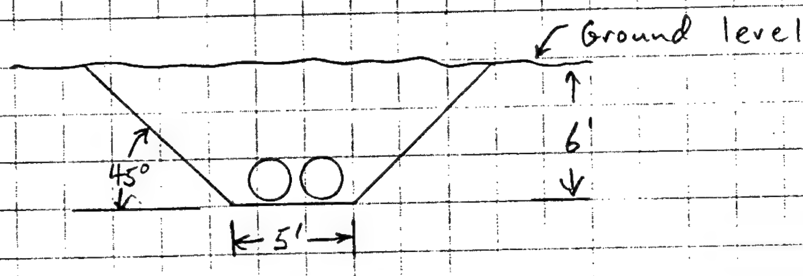
## W/o Leak Correlator

Assume 3 dig and cut operations are required to find a typical HTW leak.

Average distance between valve pits:

$$\frac{9100 \text{ lf} + 4600 \text{ lf} + 6700 \text{ lf} + 17400 \text{ lf} + 8750 \text{ lf}}{95 \text{ Valve Pits}} = 490 \text{ LF/pit}$$

Area of excavation: Assume 1 dig is 20' long and:




$6' \times 11' \times 20' = 1320 \text{ Ft}^3 \div 27 \frac{CF}{CY} = 48.9 \Rightarrow \text{say } 50 \frac{CY}{DIG} \times 3 \text{ DIGS} = 150 \text{ CY}$

Using a combination of backhoe and hand excavation and assuming 60% (150 × 0.6 = 90 CY) will be done by backhoe and 40% (150 × 0.4 = 60 CY) will be done by hand. The time required to find the leak is:

Backhoe : 90 CY × 0.080 hr/cy ÷ 24 hr/day ≈ 0.3 day (96MM p 28)
By Hand : 60 CY × 1.5 hr/cy ÷ 24 hr/day ÷ 4 men ≈ 0.94 day (96mm p 28)

HTW Lost: (See graph of 1995 Make-up water use)

Average loss during Leak = 25000 GPD
Average 1995 Make-up use = 10000 GPD

(25000 GPD − 10000 GPD) × 1.24 Day/leak ≈ 18,560 Gal/leak

RS&H.

SUBJECT Fort Stewart
Purchase Leak Correlator
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-7-96
DATE Rev. 4-12-96

ECO-11

With Leak Correlator

Assume only have to dig 20 linear feet. Vendor indicated leak could be located within inches (see call confermation) on the first dig.

Area of excavation:

$6' \times 11' \times 20' = 1320$ CF $\div 27$ CF/CY $= 49 \Rightarrow 50$ CY

Assume 60% will be done by backhoe; $50 \times 0.6 = 30$ CY
Assume 40% will be done by hand; $50 \times 0.4 = 20$ CY

Time Required:
By hand: 20 CY × 1.5 hr/CY ÷ 4 men ÷ 24 hr/day = 0.31 day (96MM p28)
W/ backhoe: 30 CY × 0.080 hr/CY ÷ 24 hr/day = 0.1 day (96MM p28)

Assume 4 hours for leak correlator test

0.31 day + 0.1 day + 0.17 day = 0.58 days/leak

HTW Lost:

(25000 GPD − 10000 GPD) × 0. day = 8,650 Gal/leak

**RS&H.**

| | | | |
|---|---|---|---|
| SUBJECT | FORT STEWART<br>PURCHASE LEAK CORRELATOR | AEP NO | 694 1331 002 |
| | | SHEET | 3 OF |
| DESIGNER | W. TODD | DATE | 2-7-96 |
| CHECKER | | DATE | Rev. 4-12-96 |

ECO - 11

W/o Leak Correlator:

O&M Costs = (From estimate EST-11B.WB2 = $9133 /YR

HTW Losses = $18{,}560 \frac{GAL}{Leak} \times 2 \frac{leaks}{YR} = 37{,}120 \frac{GAL}{YR}$

Heating Fuel Use = 141.2 mBtu/YR

Electricity Use = $54 \frac{kwh}{YR} \times 0.003413 \frac{mBtu}{kwh} = 0.2 \frac{mBtu}{YR}$

Water Cost = $37{,}120 \frac{Gal}{YR} \times \$0.5562/1000\,GAL = \$21/YR$

With Leak Correlator:

O&M Costs = (from estimate EST-11A.WB2 = $3486/YR

HTW Losses = $8650 \frac{GAL}{Leak} \times 2 \frac{leaks}{YR} = 17300\ GAL/YR$

Heating Fuel Use = 65.8 mBtu/YR

Electricity Use = $25 \frac{kwh}{YR} \times 0.003413 \frac{mBtu}{kwh} = 0.1 \frac{mBtu}{YR}$

Water Cost = $17{,}300 \frac{GAL}{YR} \times \$0.5562/1000\,GAL = \$10/YR$

ANNUAL SAVINGS

HEATING FUELS = 141.2 - 65.8 = 75.8 mBtu/YR
ELECTRICITY = 0.2 - 0.1 = 0.1 mBtu/YR
WATER = $21 - $10 = $11 /YR
O&M = $9133 - $3486 = $5647 /YR

ECO-11

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 11

RS&H No.: 694-1331-002
Date: 04/12/96
Estimator: W.T.Todd
Filename: EST-11A.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Perform leak locator test | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Excavation, backhoe to 6' | 30 | CY | 1.43 | 43 | 1.82 | 55 | 98 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 20 | CY | 0 | 0 | 29.65 | 593 | 593 | MMp28 | MMp28 |
| Remove conduit, torch | 6 | LF | 1.06 | 6 | 4.95 | 30 | 36 | MMp22 | MMp22 |
| Remove pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Weld conduit, 24" Sch 40 | 1 | Ea | 35 | 35 | 289 | 289 | 324 | MMp144 | MMp144 |
| Backfill trench, by hand | 20 | CY | | 0 | 12.85 | 257 | 257 | MMp28 | MMp28 |
| Compact backfill, by hand | 20 | CY | | 0 | 4.66 | 93 | 93 | MMp28 | MMp28 |
| Backfill trench, dozer | 30 | CY | 0.95 | 29 | 0.32 | 10 | 39 | MMp28 | MMp28 |
| Compact backfill, dozer | 30 | CY | 1.37 | 41 | 0.41 | 12 | 53 | MMp28 | MMp28 |
| Total Cost per Leak | | | | 156 | | 1647 | 1,803 | | |
| Total Cost for All Leaks | 2 | Ea | 156 | 312 | 1647 | 3294 | 3,606 | | |
| Subtotal Bare Costs | | | | 312 | | 3294 | $3,606 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 312 | | 3294 | 3,606 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -1456 | (1,456) | MMp533 | MMp533 |
| Subtotal | | | | 312 | | 1838 | 2,150 | | |
| OH & Profit Markups | | | 10% | 31 | 53% | 974 | 1,005 | MMp7 | MMp475 |
| Subtotal | | | | 343 | | 2812 | 3,155 | | |
| Sales Taxes | | | 4.0% | 14 | | NA | 14 | MMp476 | |
| Subtotal | | | | 357 | | 2812 | 3,169 | | |
| Contingency | | | 10% | 36 | 10% | 281 | 317 | MEp6 | MEp6 |
| Total Construction Cost | | | | 393 | | 3093 | 3,486 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Total Project Cost | | | | 393 | | 3093 | $3,486 | | |

LEGEND:
MEp### 1996 Means Electrical Cost Data, page ###.
MMp### 1996 Means Mechanical Cost Data, page ###.

6.6-10

ECO-11

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 11

RS&H No.: 694-1331-002
Date: 04/12/96
Estimator: W.T.Todd
Filename: EST-11B.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| | | | | | | | | | |
| Excavation, backhoe to 6' | 90 | CY | 1.43 | 129 | 1.82 | 164 | 293 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 60 | CY | 0 | 0 | 29.65 | 1779 | 1,779 | MMp28 | MMp28 |
| Remove conduit, torch | 18 | LF | 1.06 | 19 | 4.95 | 89 | 108 | MMp22 | MMp22 |
| Remove pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Weld conduit, 24" Sch 40 | 3 | Ea | 35 | 105 | 289 | 867 | 972 | MMp144 | MMp144 |
| Backfill trench, by hand | 60 | CY | | 0 | 12.85 | 771 | 771 | MMp28 | MMp28 |
| Compact backfill, by hand | 60 | CY | | 0 | 4.66 | 280 | 280 | MMp28 | MMp28 |
| Backfill trench, dozer | 90 | CY | 0.95 | 86 | 0.32 | 29 | 115 | MMp28 | MMp28 |
| Compact backfill, dozer | 90 | CY | 1.37 | 123 | 0.41 | 37 | 160 | MMp28 | MMp28 |
| | | | | | | | | | |
| Total Cost per Leak | | | | 464 | | 4241 | 4,705 | | |
| | | | | | | | | | |
| Total Cost for All Leaks | 2 | Ea | 464 | 928 | 4241 | 8482 | 9,410 | | |
| Subtotal Bare Costs | | | | 928 | | 8482 | $9,410 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 928 | | 8482 | 9,410 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -3749 | (3,749) | MMp533 | MMp533 |
| Subtotal | | | | 928 | | 4733 | 5,661 | | |
| OH & Profit Markups | | | 10% | 93 | 53% | 2508 | 2,601 | MMp7 | MMp475 |
| Subtotal | | | | 1021 | | 7241 | 8,262 | | |
| Sales Taxes | | | 4.0% | 41 | | NA | 41 | MMp476 | |
| Subtotal | | | | 1062 | | 7241 | 8,303 | | |
| Contingency | | | 10% | 106 | 10% | 724 | 830 | MEp6 | MEp6 |
| Total Construction Cost | | | | 1168 | | 7965 | 9,133 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Total Project Cost | | | | 1168 | | 7965 | $9,133 | | |

LEGEND:
MEp### 1996 Means Electrical Cost Data, page ###.
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-11

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Without Leak Locating Equipment | Date: | 05/06/96 |
| ECO Number: | 11 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

37120 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 96.0 MBtu/Yr

Heating Fuel Use = 96.0 MBtu/yr / 0.68 = 141.2 MBtu/Yr

Heating Fuel Cost = 141.2 MBtu/yr x $1.34 /MBtu = $189 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 54 kWh/Yr

Electricity Cost = 54 kWh/Yr x $0.0469 /kWh = $3 /Year

Water Cost:

37120 Gal/Yr x $0.5562 /kGal = $21 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $189 | /Year |
| Pumping (Elec) Cost | $3 | /Year |
| Water Cost | $21 | /Year |
| Total Savings | $213 | /Year |

ECO-11

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | With Leak Locating Equipment | Date: | 05/06/96 |
| ECO Number: | 11 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

17300 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 44.8 MBtu/Yr

Heating Fuel Use = 44.8 MBtu/yr / 0.68 = 65.8 MBtu/Yr

Heating Fuel Cost = 65.8 MBtu/yr x $1.34 /MBtu = $88 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.003 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.003 BHP / 0.90 x 0.746 kW/HP = 0.003 kW

Electricity Use = 0.003 kW x 8760 Hr/Yr = 25 kWh/Yr

Electricity Cost = 25 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

17300 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $88 | /Year |
| Pumping (Elec) Cost | $1 | /Year |
| Water Cost | $10 | /Year |
| Total Savings | $99 | /Year |

ECO-11

Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

| ZONE 1 PIT# | ZONE 1 LN.FT. | ZONE 2N PIT# | ZONE 2N LN.FT. | ZONE 2S PIT# | ZONE 2S LN.FT. | ZONE 3 PIT# | ZONE 3 LN.FT. | SEP ZONE PIT# | SEP ZONE LN.FT. | |
|---|---|---|---|---|---|---|---|---|---|---|
| CP–B1 | 200 | CP–V1 | 150 | V1–B1 | 700 | CP–? | 700 | C1–V1 | 1500 | (2) |
| B1–V4 | 1000 | V1–V2 | 200 | B1–V1 | 1500 | ?–1 | 800 | V1–V2 | 100 | (2) |
| V1–V2 | 600 | V2–V3 | 350 | V1–B2 | 300 | ?–2 | 400 | V2–V3 | 1700 | (2) |
| V2–V3 | 200 | V3–V4 | 650 | B2–B3 | 550 | 2–2A | 400 | V3–V4 | 450 | (2) |
| V3–V4 | 350 | V4–V5 | 600 | B3–V1 | 250 | 2A–3 | 500 | V4–V5 | 600 | (2) |
| V4–V5 | 300 | V5–V6 | 800 | V1–V2 | 250 | 3–3A | 400 | V5–V6 | 500 | (2) |
| V5–V6 | 550 | V6–V7 | 800 | V1–V3 | 350 | 3A–6 | 550 | V6–SP | 100 | (2) |
| V6–V7 | 400 | V2–V8 | 750 | V3–V4 | 250 | 4–5 | 900 | SP–V7 | 200 | |
| V7–V8 | 600 | V8–V9 | 300 | V3–V6 | 300 | 5–6 | 650 | V7–V8 | 150 | |
| V8–V9 | 350 | | | V4–V5 | 200 | 6–7 | 850 | V8–V9 | 550 | |
| V9–V10 | 350 | | | V3–V7 | 650 | 7–8 | 950 | V9–V10 | 650 | |
| V10–V11 | 250 | | | V7–V8 | 250 | 8–9 | 1000 | V10–V11 | 800 | |
| V11–V12 | 500 | | | V8–V9 | 500 | 9–10 | 1000 | V11–V12 | 650 | |
| V12–V13 | 1000 | | | V9–V10 | 200 | 10–11 | 900 | V12–V13 | 800 | |
| V13–V14 | 350 | | | V9–V11 | 450 | 11–12 | 500 | | | |
| V14–V15 | 400 | | | | | 12–13 | 950 | | | |
| V15–V16 | 400 | | | | | 13–13A | 750 | | | |
| V16–V17 | 500 | | | | | 12–14 | 950 | | | |
| V17–V18 | 800 | | | | | 14–15 | 200 | | | |
| | | | | | | 15–16 | 250 | | | |
| | | | | | | 16–16A | 300 | | | |
| | | | | | | 16A–17 | 200 | | | |
| | | | | | | 17–18 | 200 | | | |
| | | | | | | 18–19 | 100 | | | |
| | | | | | | 19–20 | 150 | | | |
| | | | | | | 20–22 | 200 | | | |
| | | | | | | 21–22 | 100 | | | |
| | | | | | | 22–23 | 350 | | | |
| | | | | | | 15–24C | 350 | | | |
| | | | | | | 24C–24B | 200 | | | |
| | | | | | | 24B–24 | 200 | | | |
| | | | | | | 24–24A | 200 | | | |
| | | | | | | 24A–25 | 150 | | | |
| | | | | | | 24A–25A | 300 | | | |
| | | | | | | 25A–26 | 100 | | | |
| | | | | | | 26–26A | 200 | | | |
| | | | | | | 26A–27 | 250 | | | |
| | | | | | | 27–28 | 250 | | | |

| | ZONE 1 | ZONE 2N | ZONE 2S | ZONE 3 | SEP ZONE | |
|---|---|---|---|---|---|---|
| TOTAL LN.FT. | 9100 | 4600 | 6700 | 17400 | 8750 | |
| MILES | 1.7 | 0.9 | 1.3 | 3.3 | 1.7 | 8.8 |
| MAX LNFT/VP | 1000 | 800 | 1500 | 1000 | 1700 | |
| AVG LNFT/VP | 479 | 511 | 447 | 458 | 625 | |
| MIN LNFT/VP | 200 | 150 | 200 | 100 | 100 | |
| NO. OF PITS (1) | 19 | 9 | 15 | 38 | 14 | 95 |

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.

(2) These pipes carry steam.

ECO-11

# CONSTRUCTION COST ESTIMATE

Project: Purchase Leak Detection Equipment
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 11

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-11.WQ1

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Leak Correlator w/ 2 | | | | | | | | | |
| sensors/transmittors | 1 | Ea | 51000 | 51000 | | 0 | 51,000 | Vendor | |
| | | | | | | | | | |
| 4.5 day on-site class | | | | | | | | | |
| room and field work | | | | | | | | | |
| training session | 1 | Ea | | 0 | 4500 | 4500 | 4,500 | | Vendor |
| Subtotal Bare Costs | | | | 51000 | | 4500 | $55,500 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | 0% | 0 | 0 | MMp533 | MMp533 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| OH & Profit Markups | | | 0% | 0 | 0% | 0 | 0 | MMp7 | MMp475 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| Sales Taxes | | | 0.0% | 0 | | NA | 0 | MMp476 | |
| Total Construction Cost | | | | 51000 | | 4500 | 55,500 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 51000 | | 4500 | $55,500 | | |

LEGEND:
Vendor Price quote from telephone conversation with vendor.

ECO-11

**RS&H®**

## Telephone Call Confirmation

Project Number 694 1331 002

Local ______ (L.D.) 800·327·2871 (Placed) B. Todd Rec'd ______ Date 2-6-96

Conversed with Tom McGee Of Fluid Conservation Systems Cincinnati, OH

Regarding Purchase of leak locating equipment

The leak locator is called a correlator, and includes two sensors with transmitters. The model C-2000 is about 10 years old. The new models are:

| | | |
|---|---|---|
| MicroCorr Cub (made in UK) | $35,000 | low end |
| Tri Corr-2001 (made in USA) | $51,000 | high end |

Correlator has receiver; input pipe diameter, type and distance between valve contact locations; usually locates the leak within inches and it is uncovered on the first dig.

They also sell a survey tool that is hand held and can be used to identify and find the general area of the leak. The cost of the survey tool is about $3,600.

They offer a training course that includes on site class room and field work for 4½ days; cost ~ $4,500

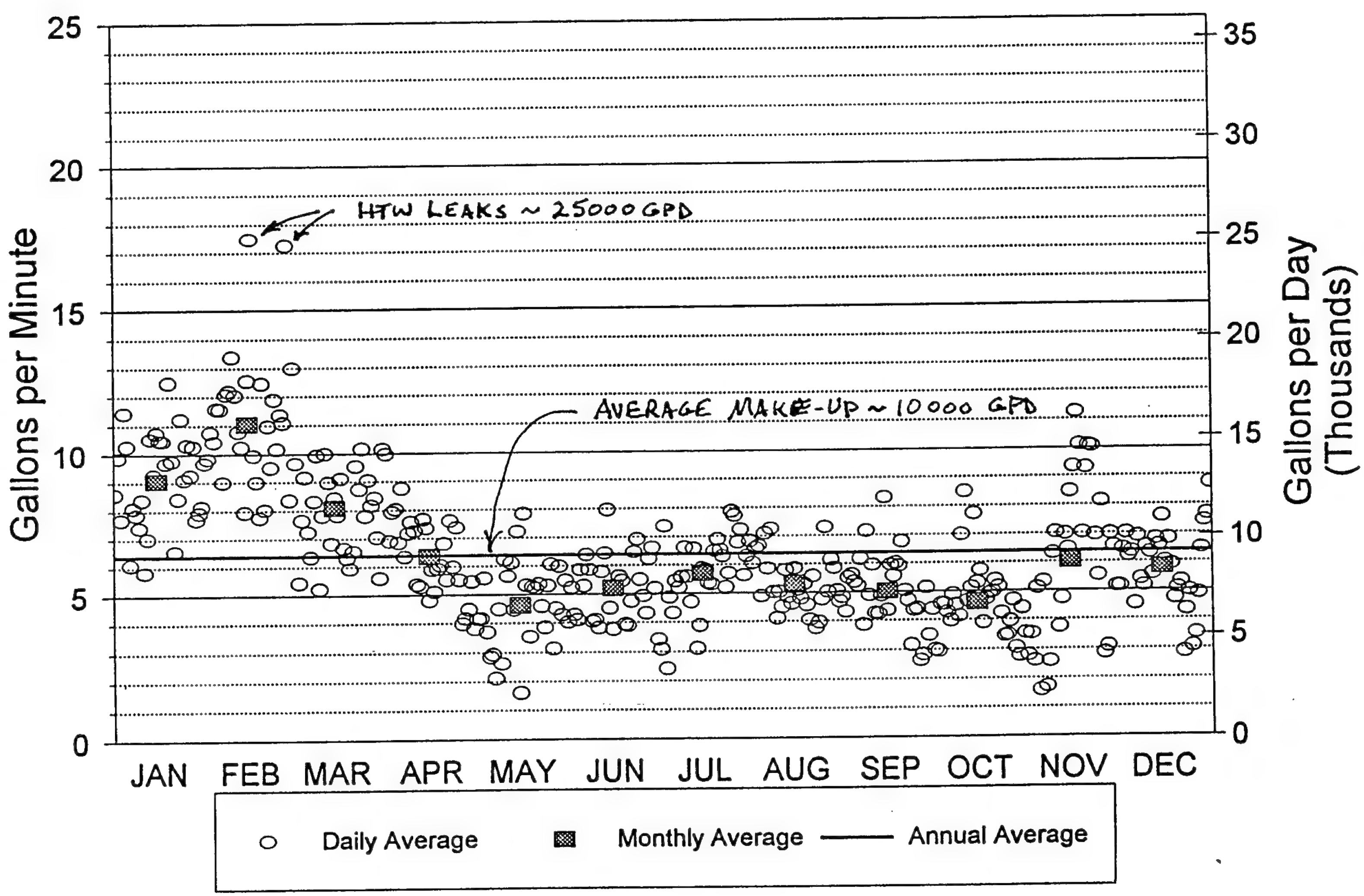
~~Distribution:~~

Tom also recommended Consumers Applied Technologies out of Orlando to do leak detection work. Contact Keith Nelson at 407·382·0995. He is also familiar with USA group.

6.6-16

## Figure 4.1-5

# Fort Stewart HTW Make-up Water, 1995




ECO-11

ECO-11

# 022 | Earthwork



| | | 022 200 \| Excav./Backfill/Compact. | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204 | 0500 | Air tamp, add A12.3 | B-9 | 190 | .211 | C.Y. | | 4.25 | .80 | 5.05 | 7.70 | 204 |
| | 0600 | Vibrating plate, add -110 | A-1 | 60 | .133 | | | 2.64 | 1 | 3.64 | 5.30 | |
| | 0800 | Compaction in 12" layers, hand tamp, add to above | 1 Clab | 34 | .235 | | | 4.66 | | 4.66 | 7.45 | |
| | 0900 | Roller compaction operator walking, add | B-10A | 150 | .080 | | | 1.90 | .57 | 2.47 | 3.58 | |
| | 1000 | Air tamp, add | B-9 | 285 | .140 | | | 2.84 | .53 | 3.37 | 5.10 | |
| | 1100 | Vibrating plate, add | A-1 | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 1300 | Dozer backfilling, bulk, up to 300' haul, no compaction | B-10B | 1,200 | .010 | | | .24 | .71 | .95 | 1.15 | |
| | 1400 | Air tamped | B-11B | 240 | .067 | | | 1.52 | 4.46 | 5.98 | 7.30 | |
| | 1600 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 800 | .015 | | | .36 | 1.19 | 1.55 | 1.86 | |
| | 1700 | Sheepsfoot roller | B-10D | 750 | .016 | | | .38 | 1.29 | 1.67 | 2.01 | |
| | 1900 | Dozer backfilling, trench, up to 300' haul, no compaction | B-10B | 900 | .013 | | | .32 | .95 | 1.27 | 1.53 | |
| | 2000 | Air tamped | B-11B | 235 | .068 | | | 1.55 | 4.56 | 6.11 | 7.40 | |
| | 2200 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 700 | .017 | | | .41 | 1.37 | 1.78 | 2.13 | |
| | 2300 | Sheepsfoot roller | B-10D | 650 | .018 | | | .44 | 1.49 | 1.93 | 2.32 | |
| 234 | 0010 | DRILLING AND BLASTING Only, rock, open face, under 1500 C.Y. | B-47 | 225 | .107 | C.Y. | 1.50 | 2.36 | 2.52 | 6.38 | 8.15 | 234 |
| | 0100 | Over 1500 C.Y. | • | 300 | .080 | | 1.50 | 1.77 | 1.89 | 5.16 | 6.50 | |
| | 2200 | Trenches, up to 1500 C.Y. | B-47 | 22 | 1.091 | | 4.50 | 24 | 25.50 | 54 | 71.50 | |
| | 2300 | Over 1500 C.Y. | • | 26 | .923 | | 4.29 | 20.50 | 22 | 46.79 | 60.50 | |
| 250 | 0010 | EXCAVATING, STRUCTURAL Hand, pits to 6' deep, sandy soil | 1 Clab | 8 | 1 | C.Y. | | 19.80 | | 19.80 | 31.50 | 250 |
| | 0100 | Heavy soil or clay | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0300 | Pits 6' to 12' deep, sandy soil | | 5 | 1.600 | | | 31.50 | | 31.50 | 50.50 | |
| | 0500 | Heavy soil or clay | | 3 | 2.667 | | | 53 | | 53 | 84.50 | |
| | 0700 | Pits 12' to 18' deep, sandy soil | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0900 | Heavy soil or clay | | 2 | 4 | | | 79 | | 79 | 126 | |
| | 1500 | For wet or muck hand excavation, add to above | | | | % | | | | 50% | 50% | |
| 254 | 0010 | EXCAVATING, TRENCH or continuous footing, common earth A12.3 | | | | | | | | | | 254 |
| | 0020 | No sheeting or dewatering included -110 | | | | | | | | | | |
| | 0050 | 1' to 4' deep, 3/8 C.Y. tractor loader/backhoe | B-11C | 150 | .107 | C.Y. | | 2.43 | 1.39 | 3.82 | 5.30 | |
| | 0060 | 1/2 C.Y. tractor loader/backhoe | B-11M | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0090 | 4' to 6' deep, 1/2 C.Y. tractor loader/backhoe | • | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0100 | 5/8 C.Y. hydraulic backhoe | B-12Q | 250 | .064 | | | 1.56 | 1.58 | 3.14 | 4.12 | |
| | 0110 | 3/4 C.Y. hydraulic backhoe | B-12F | 300 | .053 | | | 1.30 | 1.50 | 2.80 | 3.64 | |
| | 0300 | 1/2 C.Y. hydraulic excavator, truck mounted | B-12J | 200 | .080 | | | 1.95 | 3.15 | 5.10 | 6.45 | |
| | 0500 | 6' to 10' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 225 | .071 | | | 1.73 | 2 | 3.73 | 4.86 | |
| | 0600 | 1 C.Y. hydraulic excavator, truck mounted | B-12K | 400 | .040 | | | .97 | 2.17 | 3.14 | 3.88 | |
| | 0900 | 10' to 14' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 200 | .080 | | | 1.95 | 2.25 | 4.20 | 5.45 | |
| | 1000 | 1-1/2 C.Y. hydraulic backhoe | B-12B | 540 | .030 | | | .72 | 1.32 | 2.04 | 2.56 | |
| | 1300 | 14' to 20' deep, 1 C.Y. hydraulic backhoe | B-12A | 320 | .050 | | | 1.22 | 1.72 | 2.94 | 3.77 | |
| | 1400 | By hand with pick and shovel to 6' deep, light soil | 1 Clab | 8 | 1 | | | 19.80 | | 19.80 | 31.50 | |
| | 1500 | Heavy soil | • | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 1700 | For tamping backfilled trenches, air tamp, add | A-1 | 100 | .080 | | | 1.58 | .60 | 2.18 | 3.19 | |
| | 1900 | Vibrating plate, add | | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 2100 | Trim sides and bottom for concrete pours, common earth | | 600 | .013 | S.F. | | .26 | .10 | .36 | .53 | |
| | 2300 | Hardpan | | 180 | .044 | • | | .88 | .33 | 1.21 | 1.77 | |
| 258 | 0010 | EXCAVATING, UTILITY TRENCH Common earth | | | | | | | | | | 258 |
| | 0050 | Trenching with chain trencher, 12 H.P., operator walking | | | | | | | | | | |
| | 0100 | 4" wide trench, 12" deep | B-53 | 800 | .010 | L.F. | | .25 | .11 | .36 | .50 | |
| | 0150 | 18" deep | | 750 | .011 | | | .26 | .11 | .37 | .52 | |
| | 0200 | 24" deep | | 700 | .011 | | | .28 | .12 | .40 | .56 | |
| | 0300 | 6" wide trench, 12" deep | | 650 | .012 | | | .30 | .13 | .43 | .61 | |
| | 0350 | 18" deep | | 600 | .013 | | | .33 | .14 | .47 | .66 | |
| | 0400 | 24" deep | | 550 | .015 | | | .36 | .15 | .51 | .72 | |
| | 0450 | 36" deep | | 450 | .018 | | | .44 | .19 | .63 | .88 | |
| | 0600 | 8" wide trench, 12" deep | | 475 | .017 | | | .42 | .18 | .60 | .84 | |



**Important: See the Reference Section for critical supporting data - Reference Nos., Crews, & City Cost Indexes**

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ECO-11

FCS

FLUID CONSERVATION SYSTEMS

# TriCorr 2001

## Leak Correlator


The TriCorr 2001 is an advanced, portable microprocessor system for pinpointing fluid leaks in pressurized pipe systems.

It is the most advanced correlator on the market but is simple to operate and can be easily used by a single operator.

FCS specially designed the TriCorr 2001 for public and private water utilities, industrial and commercial water systems, engineering and service firms, and utility contractors.


## Typical Configuration

1. Correlator console with rechargeable battery
2. Two remote preamplifiers/radio links
3. Two high sensitivity sensors
4. 110 VAC battery charger
5. Stereo headphones
6. Cassette training tapes
7. Protective soft cases

12 VDC power cord/charger (not shown)
Operations manual (not shown)


## Additional Equipment

Sensor mounting kit
Hydrophones
Hydrophone attachment kit
Cable reels
Measuring wheel
Survey instrument
Pipe locator
Printer
Cassette recorder/player

## Size/Weight

| | |
|---|---|
| Length: | 14 inches |
| Depth: | 6 inches |
| Width: | 13 inches |
| Weight: | 14.5 lbs. (including soft cases and battery) |

## Power Supply

10V 2.5AH Battery

## Warranty

12 months parts and labor

Specifications subject to change.

ECO-11

# Features: Benefits

**Tri-Correlation:** simultaneous display of three correlation graphs simplifies evaluation of correlation results

**Peak Suppression:** eliminates interference on correlation graph

**Fast Fourier Transform (F.F.T.) Filtering:** provides real-time analysis and increased signal resolution

**True Signal Display:** provides real-time, visual leak signal verification

**Signal-to-Noise Display:** provides numerical and visual representation of correlation peaks

**Signal Spectrum Display:** focuses user toward potential leak frequencies via bar graph

**Velocity Calculation:** allows for accurate correlation if pipe material or diameter is unknown

**Multiple Pipe Type Diversity:** can correlate on up to 7 different pipe materials or diameters within the selected span

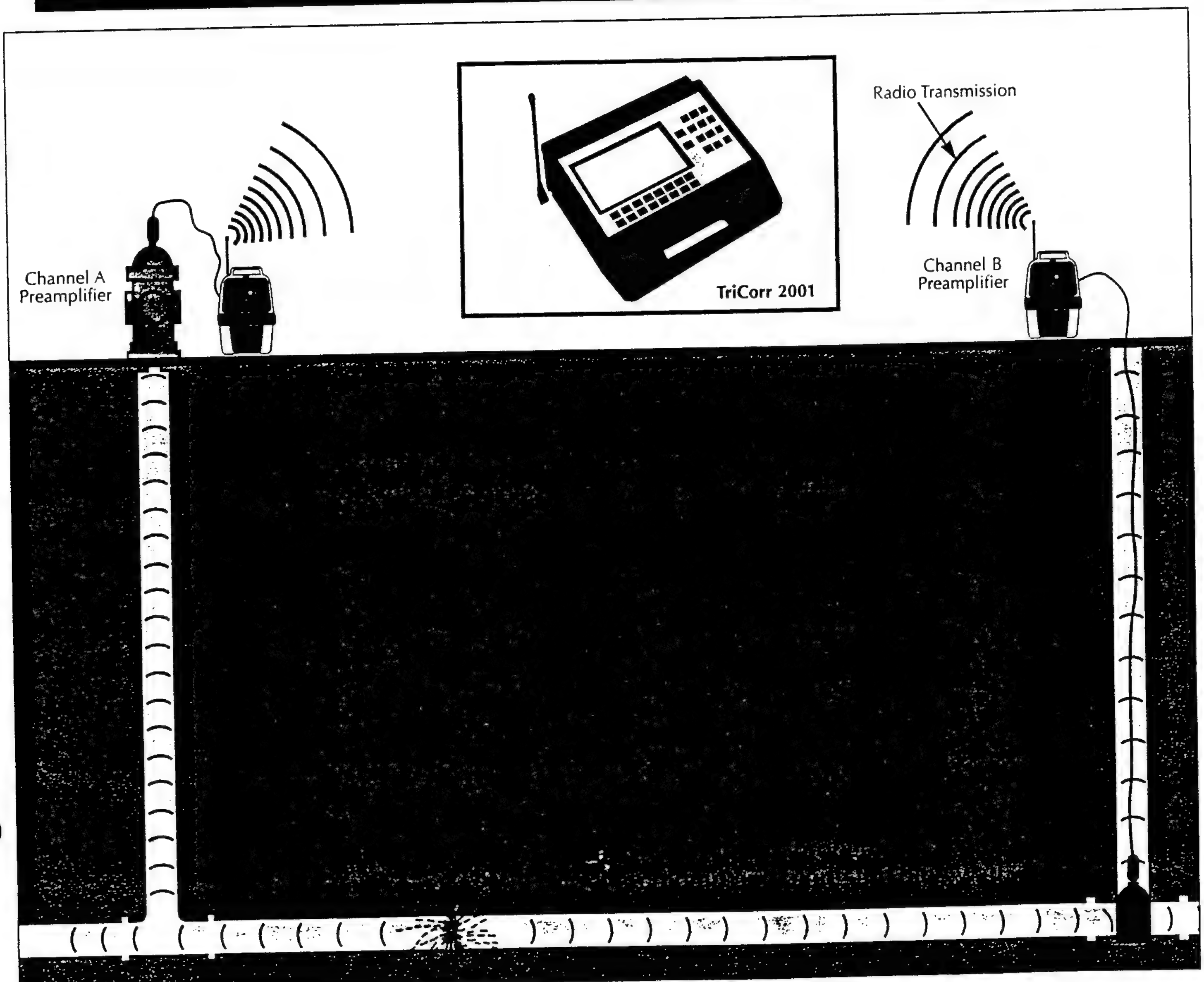
**Trial Correlation:** saves time/effort of correlating in insufficient leak signal situations

**Rugged Construction:** durable and effective in all field environments

**Easy-to-use Software:** easily used by all levels of personnel

**Large High Visibility LCD:** easy to read and interpret results

**Large Button/Water-Resistant Keypad:** can be used with gloves and in inclement weather

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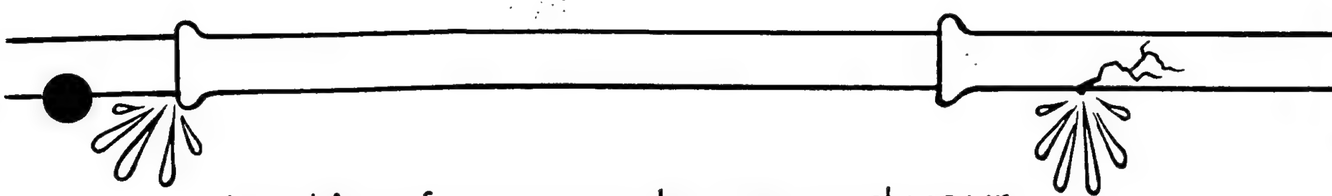
ECO-11



FCS

FLUID CONSERVATION SYSTEMS

Looking for a way to expand your leak detection program? Upgrading equipment?

Customize your own deal by choosing one of these three great options:

**1**

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- ***1 S20 Leak Survey Tool***
- ***4.5-Day Training Course***
- ***1 Additional Year Warranty***

***...save $10,400!***

**2**

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- **3 Aqualogs** for unmanned leak detection, and
- **1 laptop computer** for down-loading the data.

***...save $16,570***

**3**

Or...***TRADE IT!***

We'll take **your** leak correlator (any make) as a trade-in, and give you $8,585 towards the purchase of a brand new TriCorr 2001 system!

***...save $8,585***

Call our sales department now at 800-531-5465 for information on this ***limited time offer!***

*offer expires 3/30/96*

**--The Water Accountability Specialists--**
Fluid Conservation Systems Inc.
2001 Ford Circle Suite F
Milford, Ohio 45150
(800) 531-5465 (513) 831-9336 fax

A HALMA GROUP COMPANY

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progress quickly and easily through the logical software programme, using the inbuilt push button keypad, to obtain fast accurate results. ECO-11

The central unit of rigid polyurethane construction is easily portable, weighing only $3^1/_2$ kg. Correlation results are displayed on the high contrast liquid crystal display, which is backlit for night time or poor visibility operation.

Filter and velocity settings are automatically allocated dependent on pipe type, diameter and other data entered. There is the option of manual filter choice, aided by audio monitoring using the studio quality headphones provided. Where pipe data is not available, velocity can be quickly and easily measured to ensure accuracy of results.

For a pipe run of mixed materials or diameter, the mixed material function allows data for different pipe sections to be entered. The system automatically compensates and chooses velocity and filter settings accordingly.

The zoom function reduces resolution errors by allowing detailed examination of specific sections of the correlator graphic. Results can be stored for later examination or printed on the portable thermal printer (available as an accessory).

## • MICROCORR CUB TECHNICAL SPECIFICATION •

| MicroCorr® Unit | | Features |
|---|---|---|
| Frequency response | 37-5000 Hz | Battery level indication |
| Filters: high pass | 37,75,150,300,600 Hz | Auto shutdown |
| low pass | 310,625,1250,2500,5000 Hz | Survey mode |
| Max time delay | 1550 ms | Velocity measurement |
| Max theoretical range | 2.1km (iron pipe) 750m (pvc pipe) | Auto gain |
| Resolution | +\-0.1m | Signal level display |
| Display type | Backlit LCD | Context related help |
| Battery supply | 12v lead acid | Language options |
| Battery life | 15 hours | Download to PC |
| Mixed materials | 3 sections | Real time clock/display |
| Printer | RS232 interface | |
| Memory | 66 correlations | |
| Construction | Rigid polyurethane | |
| Dimensions | 330 x 230 x 145mm | |
| Weight | 3.65kg | |

| Transmitter Unit | | Features |
|---|---|---|
| Transmitter range | 2000m | Top mounted controls |
| Level indication | Meter | Auto gain |
| Battery type | 12v lead acid 2.3 Ah | Interchangeable battery |
| Battery level indication | Test switch | |
| Battery life | 8 hours typical | |
| Weight | 2.2kg | |
| Dimensions | 140 x 165 x 300mm | |
| Case construction | Rigid polyurethane | |

**PALMER ENVIRONMENTAL**
Ty Coch House, Llantarnam Park Way, Cwmbran, Gwent NP44 3AW, United Kingdom
Telephone (01633) 489479 Int +44 1633 489479
Telefax (01633) 877857 Int +44 1633 877857

# ENERGY PROJECT

# PROGRAMMING DOCUMENTATION

**Project Number and Title**

ECO-12B Reduce boiler and HTW system operating pressure to 60 psig.

**Project Funding Category**

Federal Energy Management Program (FEMP)

**Contents**

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 1

DESCRIPTION OF WORK

## ECO Number 12

Reduce boiler and HTW system operating pressure.

**Discussion**

When the No. 4 boiler was initially installed, the system was operated at approximately 225 psig. This might be because the boiler was designed for that pressure and performance guarantees made by the manufacturer required design operating conditions to demonstrate contractual compliance. Soon after start-up, it was determined that the circulating pump seals were failing too frequently. To increase the seal life, the operating pressure on the entire system was reduced to its current level. The boilers and HTW system are currently operated at about 180 psig and the corresponding saturation temperature of 380 degrees F.

During the non-heating season, the energy requirement on the system is rather low. Unit No. 4 carries the whole load which rarely exceeds 50 percent boiler capacity. Heating requirements during this time are limited to domestic hot water in the barracks and dining facilities and autoclave operation at the hospital. Pressure requirements are limited to soot blowing on the No. 4 boiler where the blower set pressure is 80 psig.

A study of underground piping heat losses completed at Ft. McClellan, Alabama showed a heat transfer rate of 55 Btu/Hr-LF for pipes with dry insulation. Pipes with deteriorated and moist insulation had a heat transfer rate of about 275 Btu/Hr-LF. These heat transfer rates were applied to the Fort Stewart HTW piping. The heat loss calculations assumed approximately one-half of the pipes have deteriorated and/or moist insulation. This assumption was based on observations of the pipes in the valve pits and steam flow from the conduit vents. It was also assumed that the heat transfer losses are proportional to the temperature difference between the fluid and the surrounding soil. The calculations yielded a current annual HTW distribution system heat loss of about 160,000 MBtu which required a heating fuel input of about 235,300 MBtu/Year.

Reducing the boiler and HTW system operating pressure and temperature will reduce the heat losses from the system to the surroundings. Operating at lower pressures will result in less stress on the system components; however, the O&M savings would be impossible to estimate with any confidence. Therefore, O&M savings are not included in the economic analysis.

### Option B: Reduce Boiler and HTW System Pressure to 60 psig.

**Description - Option B**

This option consists of installing an adjustable steam pressure reducing station between the No. 4 boiler and the main steam header, operating the boiler at 100 psig and operating the HTW system at 60 psig.

The highest temperature requirement on the Fort Stewart HTW system are the autoclaves in the hospital. Autoclaves are used for sterilizing surgical instruments. They operate between 280 degrees F and 325 degrees F which requires 50 psig to 80 psig steam, respectively. The No. 4 boiler has to operate at 100 psig to produce its own soot blowing steam. The pressure in the rest of the system can be lowered to 60 psig and still satisfy the heating demands of the rest of the post including the hospital. Reducing the HTW system pressure from 180 psig (380 degrees F) to 60 psig (307 degrees F) would result in a heating fuel energy savings of about 53,115 MBtu/Year.

If the end use systems cannot maintain the desired temperatures during the winter months, the pressure can be adjusted up until all requirements are satisfied.

The CEP operators expressed concern that this would add more controls that will possibly fail in the future. They are correct because any control system is subject to failure over time. However, the steam pressure control station can be installed such that the CEP can be returned to normal operation if the controls require maintenance.

When a boiler is being considered for operation below its design operating pressure, the possible reduction of boiler capacity should also be considered. This is theoretically true for all boilers, however, its practical significance applies when the change in operating pressure is very high. High pressure boilers are usually designed with smaller diameter tubes for structural, thermodynamic and economic reasons. At normal design pressures a bubble of steam formed in the tube would occupy a certain portion of the tube's diameter. At lower pressures the same bubble would occupy a greater portion of the tube cross section. As the firing rate increases to full load, the bubble might take up the entire tube diameter. This condition could interrupt circulation of the cooling water through the tube, cause insufficient cooling of the tube wall and possibly result in tube failure.

The increase in specific volume of the steam could also cause an increase the velocity of the steam passing through the steam drum internals. The steam drum internals, which are designed to separate the water droplets from the steam, might show a reduction in performance due to the increased velocity. The velocity increase for a given load is equal to the ratio of the specific volumes for the two pressures under consideration. Low pressure boilers have larger diameter tubes and the heat releases are lower. The result is low pressure boilers are much less susceptible to the negative effects of reduced pressure operation.

The Fort Stewart boilers do not operate near full load. Typically, when the boiler load gets above 85% an additional boiler is brought into service to keep the load on any one boiler in the "comfortable" range. Therefore, the conclusion is that operating the wood fired boiler at 100 psig and the package boilers at 60 psig

should not cause any boiler problems. The following table lists the pros and cons for operating at reduced pressures.

| Boiler Operation Below Design Pressures | | |
|---|---|---|
| Pressure | PROS | CONS |
| 60 psig | • Increased boiler efficiency.<br>• Reduced thermal losses from HTW distribution system.<br>• Increased life of pump seals.<br>• Reduced occurrence of HTW leaks from valves and fittings.<br>• Reduced flow rates from existing HTW system leaks.<br>• No condensate dumping required during SEP startup. | • May require re-calibration of steam flow meters.<br>• Requires installation of 100 psi to 60 psi pressure reducing station .<br>• May cause interruption of boiler circulation.<br>• Pressure may have to be increased during the heating season. |

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 2

LIFE CYCLE COST ANALYSIS SUMMARY

ECO-12B

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-12
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 26657. | | |
| B. SIOH | $ 1600. | | |
| C. DESIGN COST | $ 1600. | | |
| D. TOTAL COST (1A+1B+1C) | $ 29857. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 29857. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 53115. | $ 71174. | 14.88 | $ 1059071. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 53115. | $ 71174. | | $ 1059071. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 71174.

5. SIMPLE PAYBACK PERIOD (1G/4) .42 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1059071.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 35.47
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO-12A IMPLEMENTED

ECO-12B

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-12X
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 26657. | | |
| B. SIOH | $ 1600. | | |
| C. DESIGN COST | $ 1600. | | |
| D. TOTAL COST (1A+1B+1C) | $ 29857. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 29857. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 22871. | $ 30647. | 14.88 | $ 456029. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 22871. | $ 30647. | | $ 456029. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 0. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.88 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 0. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 30647.

5. SIMPLE PAYBACK PERIOD (1G/4) .97 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 456029.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.27
(IF < 1 PROJECT DOES NOT QUALIFY)

PROGRAMMING DOCUMENTATION - FEMP

ATTACHMENT 3

CALCULATIONS, COST ESTIMATE AND BACK-UP DATA

**RS&H.**

SUBJECT FORT STEWART
REDUCE OP. PRESSURE
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-13-96
DATE

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B: REDUCE PRESSURE TO 60 psig
SATURATION TEMPERATURE FOR 60psig = 307 °F
NOTE: 60PSIG WAS CHOSEN BECAUSE THE AUTOCLAVES IN THE HOSPITAL REQUIRE 50-80 PSIG STEAM.

ENERGY SAVED IN DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (121737-17500)\text{ft} \times \frac{(275+55)}{2}\ \text{BTU/Hr·Ft} \times 8760\ \text{HR/yr}}{1E6\ \text{BTU/MBTU}}$$

$$= 34{,}006\ \text{MBTU/yr.}$$

$$Q_{SEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (17500)\text{ft} \times \frac{(275+55)}{2}\ \text{BTU/HR·FT} \times 135\ \text{D/yr} \times 24\ \text{H/D}}{1E6\ \text{BTU/MBTU}}$$

$$= 2112\ \text{MBTU/yr.}$$

$$Q_{TOT} = \frac{Q_{CEP} + Q_{SEP}}{0.68}$$

$$= \frac{(34006 + 2112)\ \text{MBTU/yr}}{0.68}$$

$$= \boxed{53{,}115\ \text{MBTU/yr}}$$

ANNUAL COST SAVINGS

SAVINGS = 53,115 MBTU/yr × 1.34 \$/MBTU

= 71,174 \$/yr

RS&H.

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 3 OF
DATE 2-13-96
DATE

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B (CONTINUED)

THE BOILER PRESSURE MUST REMAIN AT APPROXIMATELY 100 PSIG TO SUPPLY ITS OWN SOOT BLOWING PRESSURE.

A PRESSURE REDUCING STATION MUST BE PROVIDED TO REDUCE THE STEAM PRESSURE FROM 100 PSIG TO 60 PSIG. THE PRESSURE REDUCING STATION INCLUDES:

- 1 PRV W/ PNEUMATIC ACTUATOR
- 1 PRESSURE TRANSMITTER
- 1 PRESSURE CONTROLER W/SET POINT ADJUSTMENT.

INSTALLATION COST

SEE ESTIMATE SHEET.

RS&H

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 7 OF
DATE 2-13-96
DATE

CURRENT PIPING ENERGY LOSS

$Q_{CEP} = (121737 - 17500)\,ft \times (275+55)/2$ BTU/HR·FT $\times 8760$
$104237 \times 165 \times 8760$
$= 150{,}664$ MBTU/yr

$Q_{SEP} = (17500)\,ft \times (275+55)/2$ BTU/HR·FT $\times 135 \times 24$

$= 9355$ MBTU/yr

$Q_{TOT} = 150{,}664$ MBtu/YR $+ 9355$ MBtu/YR $= 160019$ MBtu/YR

Current fuel use $= 160{,}019 \frac{MBtu}{YR} \div 0.68 = \underline{235{,}322 \frac{MBtu}{YR}}$

**RS&H**

SUBJECT FORT STEWART
DESIGNER W.T. TODD
CHECKER

AEP NO 694-1331-002
SHEET ___ OF ___
DATE 2-19-96
DATE

OPERATE HTW SYSTEM AT LOWER PRESSURES

AFFECT ON OTHER ECO'S

| OP. PRESSURE | HTW TEMP. | ΔT (1) | HEAT LOSS (2) |
|---|---|---|---|
| 180 PSIG | 380 °F | 310 °F | 258.7 $\frac{MBtu}{YR}$ |
| 100 PSIG | 338 °F | 268 °F | 223.6 $\frac{MBtu}{YR}$ |
| 60 PSIG | 307 °F | 237 °F | 197.8 $\frac{MBtu}{YR}$ |

(1) Based on HTW make-up water temperature of 70 °F.
(2) See spreadsheet calculations on following 3 pages. Loss is for fictitious loss of 100,000 Gal/year.

All ECO's that reduce the HTW losses will be affected by operation at lower pressures. The energy savings for these ECO's will be reduced by the following amounts:

180 PSIG → 100 PSIG :

$$\% \text{ Change} = \frac{257.8 - 223.6}{257.8} \Rightarrow \underline{13.57\ \%}$$

100 PSIG → 60 PSIG :

$$\% \text{ Change} = \frac{223.6 - 197.8}{223.6} \Rightarrow \underline{11.54\ \%}$$

ECO-12B

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | Existing Conditions |
| ECO Number: | All |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/19/96

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 258.7 MBtu/Yr

Heating Fuel Use = 258.7 MBtu/yr / 0.68 = 380.4 MBtu/Yr

Heating Fuel Cost = 380.4 MBtu/yr x $1.34 /MBtu = $510 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $510 | /Year |
| Pumping (Elec) Cost | $7 | /Year |
| Water Cost | $56 | /Year |
| Total Savings | $573 | /Year |

6.7-14

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | With ECO-12 Option A |
| ECO Number: | All |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/19/96

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 338 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | \$1.34 | /MBtu |
| 8. Electricity cost | \$0.0469 | /kWh |
| 9. Water cost | \$0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 268 °F = 223.6 MBtu/Yr

Heating Fuel Use = 223.6 MBtu/yr / 0.68 = 328.9 MBtu/Yr

Heating Fuel Cost = 328.9 MBtu/yr x \$1.34 /MBtu = \$441 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x \$0.0469 /kWh = \$7 /Year

Water Cost:

100000 Gal/Yr x \$0.5562 /kGal = \$56 /Year

Total Utility Cost Savings:

| | |
|---|---|
| Heating Fuel Cost | \$441 /Year |
| Pumping (Elec) Cost | \$7 /Year |
| Water Cost | \$56 /Year |
| Total Savings | \$504 /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | With ECO-12 Option B | Date: | 02/19/96 |
| ECO Number: | All | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 307 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 237 °F = 197.8 MBtu/Yr

Heating Fuel Use = 197.8 MBtu/yr / 0.68 = 290.8 MBtu/Yr

Heating Fuel Cost = 290.8 MBtu/yr x $1.34 /MBtu = $390 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

| | |
|---|---|
| Heating Fuel Cost | $390 /Year |
| Pumping (Elec) Cost | $7 /Year |
| Water Cost | $56 /Year |
| Total Savings | $453 /Year |

ECO-12B

# CONSTRUCTION COST ESTIMATE

Project: Reduce Operating Pressure
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 12

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: G.W. Fallon
Filename: EST-12.WQ1

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Pressure Reducing Station, w/ controls | 1 | ea | 22233 | 22233 | 305 | 305 | 22,538 | Vendor | MMp192 |
| 300 lb flange, 10" dia Weld Neck | 2 | ea | 220 | 440 | 145.5 | 291 | 731 | MMp165 | MMp165 |
| Welding Labor | 2 | ea | 0 | 0 | 123.15 | 246 | 246 | | MMp144 |
| Subtotal Bare Costs | | | | 22673 | | 842 | $23,515 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 22673 | | 842 | 23,515 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -372 | (372) | MMp533 | MMp533 |
| Subtotal | | | | 22673 | | 470 | 23,143 | | |
| OH & Profit Markups | | | 10% | 2267 | 53% | 249 | 2,516 | MMp7 | MMp475 |
| Subtotal | | | | 24940 | | 719 | 25,659 | | |
| Sales Taxes | | | 4.0% | 998 | | NA | 998 | MMp476 | |
| Total Construction Cost | | | | 25938 | | 719 | 26,657 | | |
| Design Fee | | | | NA | 6.0% | 1599 | 1,599 | | |
| SIOH | | | | NA | 6.0% | 1599 | 1,599 | | |
| Subtotal | | | | 25938 | | 3917 | 29,855 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 25938 | | 3917 | $29,855 | | |

LEGEND:
Vendor Telephone/fax quote from manufacturers rep.
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-12B

**FISHER·ROSEMOUNT**

Key Controls Inc.
Jacksonville Branch
1409 Kingsley Ave. Suite 7B
Orange Park, Florida 32073-4532
Tel 1 (904) 269-5455
Fax 1 (904) 269-5446

February 13, 1996

Reynolds, Smith & Hills Inc.
4651 Salisbury Rd.
Jacksonville, FL 32216

Attn: George Fowler

RE: Budgetary Proposal Steam Pressure Control Valve; Key Controls' Quotation #96-32080

Dear Mr. Fowler:

Thank you for your inquiry. As per your conversations with Wes King, we are pleased to quote budgetary pricing on the following Fisher Controls' products.

Item 1 Qty. 1

8" x 6" Fisher Type EWD globe control valve. ANSI Class 300# carbon steel body, 416 SST seat ring, 17-4PH SST plug, 416 SST Whisper III cage. Operated by a Fisher Type 471-16, size 60, pneumatic double-acting piston actuator, and Fisher Type 3570 pneumatic valve positioner. 60 psig actuator supply. 3-15 psig positioner input. Increasing signal to open. An external fail-safe device would be required to achieve failure for this valve. Also includes Fisher Type 4195KB, proportional-plus reset pneumatic controller. 300 psig bourdon tube element. With 2" pipestand mounting.

UNIT PRICE = $ 22,233.30
ESTIMATED DELIVERY = 10-12 WKS ARO

Pricing for this estimate is firm for 30 days from today's date, and is quote FOB shipping point, with surface freight allowed to jobsite.

Please find enclosed a control valve specification sheet, detailing valve construction and selected service conditions. If you have any further questions, please contact Tom Glaspie or Wes King at your convenience.

Sincerely yours,

Wes King



6.7-18

ECO-12B

**Fisher Controls** — **Control Valve Specification**

FISHER®

Customer: G. Fowler
Reference: Fort Stewart
Order No: —
Quote No:
Date 2/13/96 Page 1 of 1

| | | |
|---|---|---|
| Item | | 1 |
| Quantity | | 1 |
| Application | | Steam Press. Control |
| Tag | | |
| Size and Type | | 8" x 6" 470-16-EWD |
| Body | Style | [x] Globe [ ] Angle [ ] |
| Body | End Connections | [ ] Scrd [ ] SWE [x] Flg 300 ANSI RF [ ] BWE Schedule ___ Casting Rating ___ [ ] |
| Body | Material | [ ] Iron [ ] 316 SST [x] Steel [ ] |
| Body | Number of Ports | [x] One [ ] Two |
| Body | Push Down to | [x] Close [ ] Open |
| Body | Flow Direction | [ ] Down [x] Up |
| Trim | Trim Number | 301 |
| Trim | Cage or Retainer Material | 416SS Whisper III |
| Trim | Bushing Material | — |
| Trim | Seat Ring Material | 416SS |
| Trim | Valve Plug – Material | 17-4 ph SS |
| Trim | Valve Plug – Guiding | [x] Cage [ ] Top [ ] Stem [ ] Port [ ] Top & Bottom |
| Trim | Valve Plug – Balance | [x] Balanced [ ] Unbalanced |
| Trim | Port Size | [ ] Full Ø 5 3/8" |
| Trim | Characteristic | [ ] Quick-Opening [x] Linear [ ] Equal-Percentage [ ] |
| Trim | Shutoff Class | [x] Standard [ ] |
| Bonnet | Style | [x] Std [ ] Ext. # |
| Bonnet | Boss Size | [x] Std [ ] |
| Bonnet | Packing | [x] TFE [ ] Lubr & Isol Valve [ ] TFE Asb [ ] [ ] Lam Graphite |
| Bonnet | Bolting – Bonnet | [x] Std [ ] |
| Bonnet | Bolting – Pack. Flg. | [x] Std [ ] |
| Actuator | Style | [x] Piston [ ] Diaph [ ] |
| Actuator | Size | 60 |
| Actuator | Air to Actuator | [ ] 3 to 15 [ ] 6 to 30 [x] 60 |
| Actuator | Air Fails Valve to | [ ] Close [ ] Open [ ] Lock |
| Actuator | Handjack | [ ] Top [ ] Side |

| | | |
|---|---|---|
| Positioner | Type | [ ] 3582 [ ] 3590 [x] 3570 |
| Positioner | Input Signal | [x] 3 to 15 psi [ ] 4 to 20 mA [ ] 6 to 30 psi [ ] 10 to 50 mA [ ] [ ] |
| Positioner | Accessories | [x] Airset [x] Gauges [ ] Bypass |
| Positioner | Increase Signal Valve | [ ] Closes [x] Opens |
| I/P Positioner Only | Certification† | [ ] None |
| I/P Positioner Only | Explosion-proof | [ ] CSA |
| I/P Positioner Only | Intrinsically safe | [ ] FM [ ] CSA |
| Controller | Type | 4195KB |
| Controller | Action | [x] Direct [ ] Reverse |
| Controller | Measuring Element | [x] Bourdon Tube [ ] Bellows Range 360 Psig; [ ] Bronze [ ] Steel [x] SST |
| Controller | Output (Psig) | [x] 3 to 15 [ ] 6 to 30 [ ] |
| Controller | Mounting | [ ] Yoke [ ] Csg [x] Remote |
| Controller | Airset | [x] 67AFR-221 [ ] |
| Controller | Airset Mounting | [ ] Yoke [x] Nipple |
| 646 Transducer | Input Signal (mA) | [ ] 10 to 50 [ ] 4 to 20 [ ] |
| 646 Transducer | Output Signal (Psig) | [ ] 3 to 15 [ ] 6 to 30 [ ] |
| 646 Transducer | Action | [ ] Direct [ ] Reverse |
| 646 Transducer | Mounting | [ ] Yoke [ ] Csg [ ] Pipe |
| 646 Transducer | Airset | [ ] 67AFR-362 [ ] |
| 646 Transducer | Certification† | [ ] None |
| 646 Transducer | Explosion-proof | [ ] FM [ ] CSA |
| 646 Transducer | Intrinsically safe | [ ] FM [ ] CSA |

**Service Conditions**

[x] Throttling [ ] On-Off [ ] PRV [ ] Relief

| Flowing Media | Sat. Steam | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Specific Gravity | | | |
| Inlet Temperature °F | | 400 | |
| Inlet Pressure (Psig) | 100 | 100 | 200 |
| Inlet Vapor Pressure | | | |
| ΔP Sizing (Psi) | 85 | 40 | 140 |
| ΔP Shutoff (Psi) | | 200 | |
| Flow Rate, Give Units #/hr | 100,000 | 100,000 | 100,000 |
| Req'd Flow Coeff., [ ] $C_v$ [x] $C_g$ [ ] $C_s$ | 13,146 | 15,181 | 9695 |
| Valve Coefficient | | 15,500 | |
| Recovery Coeff., [ ] $K_m$ [x] $C_1$ | | 33.7 | |
| Noise Level (dBA) | 98.6 | 82.9 | 87.2 |
| Line Size (in.) | | 8" STD | |

Notes and/or Special Constructions

PREPARED BY: WK
DATE: 2/13/96
KEY CONTROLS INC.
1409 KINGSLEY AVE.
ORANGE PARK, FL 32073

Worksheet

| Approximate Shipping Weight, Lb. | List Price | $ |
|---|---|---|
| | Unit Net Price | $ |
| | Total Net Price | $ |

† Please insure proper certification requirements or barrier interface before entering order. See Hazardous Area Certifications Bulletin 9.2:001.

Form 2881D

CONF-8406132--2 ECO-12B



# ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132

DE84 014051

Gerald D. Pine and Michael A. Karnitz

Energy Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831

615 576-5454

574-5150

For presentation at the
75th Annual Conference of the International
District Heating Association
Mount Washington, New Hampshire

June 17-20, 1984

MASTER



*Research sponsored by the U. S. Army, Construction Engineering Research Laboratory, under Interagency Agreement Number 40-1361-83, Army Number CERL-83-080, operated by Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-84OR21400 with the U.S. Department of Energy.



6.7-20

ECO-12B

Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

## 5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 338°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

# 7.0 LOW COST/NO COST PROJECT DOCUMENTATION

# ENERGY PROJECT DOCUMENTATION

## Project Number and Title

ECO-2  Reduce blow down of the cascade heaters and the wood-fired boiler.

## Project Funding Category

Low Cost/No Cost

## Contents

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 1

DESCRIPTION OF PROJECT AND WHY PROJECT IS RECOMMENDED

## ECO Number 2

Reduce blowdown of the cascade heaters and the wood-fired boiler.

**Description**

Blowing down the boiler is required to control the water chemistry inside the boiler. Insufficient blowdown can severely damage the boiler pressure parts and increase the corrosion rate of the HTW distribution system piping. Excessive blowdown of the boilers and cascade heaters wastes water, chemicals and energy which increases the operating costs of the CEP. The boilers and cascade heaters should be blown down as little as possible, while keeping the boiler water chemistry under control.

The current practice is to blowdown all points once per shift. Typically, the blowdown duration is as short as possible. The valve is opened fully, allowed to blowdown for ten seconds and then closed. As a practical matter, the duration of each blowdown cannot be reduced very much, however, the frequency of blowdown can be reduced. This project involves reducing the frequency of boiler Number 4 and cascade heater blowdown operations currently being used.

Dissolved and suspended solids accumulate in the boiler water and HTW. These solids originate from a number of sources inside and outside the HTW system. The concentration of these solids must be maintained below a maximum value to assure continued operation of the boiler and cascade heaters. Operators manually open blowdown valves on both the boiler and the cascade heaters to flush away the accumulation of solids. Fresh make-up water, which is relatively free of solids, is pumped into the system to maintain the desired water level.

The American Boiler Manufacturer's Association (ABMA) recommends the following water concentrations for boilers operating below 300 psig - less than 3,500 parts per million (ppm) total dissolved solids, less than 700 ppm alkalinity and less than 300 ppm total suspended solids. Total dissolved solids is directly related to the quantity of blowdown. Three of the boiler water analysis reports (see Appendix A.3) by Puckorius & Associates (P&A) for 1995 list total dissolved solids for boiler Number 4 at 1,800 ppm, 1,750 ppm and 1,400 ppm. These values are well below the recommended parameters, which indicates the boilers are being blown down too much. The P&A reports call for a control range of 3,000 ppm to 3,500 ppm for total dissolved solids and they also recommend that the blowdown be reduced. Having low total dissolved solids does not adversely affect the HTW system. However it means water, chemicals and energy are being wasted.

Blowdown losses were estimated by identifying all system blowdown points, frequencies and durations. The flow from each point was calculated and all of the points summed to obtain an average daily blowdown quantity. The total blowdown losses are estimated to be approximately 1,440 GPD. The boiler water analysis reports indicate that the concentrations of total dissolved solids are about one-half of the recommended value, therefore, the blowdown frequency should be reduced by approximately 50 percent. Reducing the blowdown frequency from every day to every other day would lower the HTW losses to about 720 GPD. There may be some operation and maintenance savings in addition to the energy and water savings, but they were not included in the economic analysis.

**Results**

| | |
|---|---|
| Construction Costs | \$500 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0 |
| Heating Fuels (MBtu/Year) | 1,000 |
| Water (Gallons/Year) | 262,800 |
| Annual Energy Cost Savings | \$1,340 |
| Annual Water Cost Savings | \$150 |
| Annual O&M Cost Savings | \$2,360 |
| Savings to Investment Ratio (SIR) | 114 |
| Simple Payback (Years) | 0.13 |

**Recommendations**

Based on the life cycle cost analysis, this project is recommended. Finding the right combination of frequency and duration is a trial and error process. Fortunately, the solids concentration in the HTW system will change very slowly. It may take weeks to raise the solids concentration to the desired level. To make this process as easy as possible, boiler operating staff should maintain all of the current blowdown durations but reduce the frequency to every other day. When the solids concentration rises to the desired level, boiler water analysis will indicate if the blowdown duration should be increased or reduced to maintain the proper level.

The CEP staff indicated the causticity would rise when they reduced the blowdown frequency. This may be due to high alkalinity of the make-up water. When blowdown is reduced, the alkalinity in the boiler cycles up causing the causticity to rise. If this is the problem, a dealkalizer (which is similar to a water softener) could be installed to remove the undesirable alkalinity from the make-up water. This problem should be investigated further by the CEP staff and the water analysis contractor.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 2

SKETCH OF LOCATION AND/OR WORK REQUIRED

Sketch of Location and Work Required for ECO-2:

No sketch required. The location of this project is in the Central Energy Plant and in the Satellite Energy Plant. The work for this project is described in detail by Attachment 1 and involves operator labor only.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 3

COST ESTIMATE AND BACK-UP DATA

ECO-2

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Reduce Blow Down | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 05/24/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 2 | Filename: | EST-2.WB2 |

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Boiler Water Analysis | 5 | Ea | 0 | 0 | 100 | 500 | 500 | | Est. |
| Subtotal Bare Costs | | | | 0 | | 500 | $500 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | 0% | 0 | 0 | MMp533 | MMp533 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| OH & Profit Markups | | | 0% | 0 | 0% | 0 | 0 | MMp7 | MMp475 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| Sales Taxes | | | 4.0% | 0 | | NA | 0 | MMp476 | |
| Total Construction Cost | | | | 0 | | 500 | 500 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Subtotal | | | | 0 | | 500 | 500 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 0 | | 500 | $500 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-2

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-2
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

| | | | | |
|---|---|---|---|---|
| 1. INVESTMENT | | | | |
| A. CONSTRUCTION COST | $ 500. | | | |
| B. SIOH | $ 0. | | | |
| C. DESIGN COST | $ 0. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 500. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | | $ 500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1000. | $ 1340. | 14.88 | $ 19939. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1000. | $ 1340. | | $ 19939. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 2505. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.88 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 37274. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3845.

5. SIMPLE PAYBACK PERIOD (1G/4) .13 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 57214.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 114.43
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart | AEP NO | 694 1331 002 |
| | Reduce Blowdown | SHEET | OF |
| DESIGNER | G. Fallon | DATE | 2-7-96 |
| CHECKER | | DATE | |

ECO No. 2 REDUCE BLOWDOWN FREQUENCY

BOILER WATER TESTS SHOW WATER IS CLEANER THAN IT SHOULD BE, IMPLYING BLOWDOWN FREQUENCY IS TOO HIGH FOR SOLIDS BEING GENERATED.
INITIALLY, BLOWDOWN FREQUENCY SHOULD BE REDUCED, PERHAPS TO ODD NUMBERED DAYS AND THE DURATION OF BLOWDOWN SHOULD NOT BE CHANGED.

CURRENT HTW USE (see table for calculation)

$1440 \frac{GAL}{Day} \times 365$ days/yr $= \underline{525600 \text{ GAL/YR}}$

ANNUAL COST for O&M

30 min/day × 365 day/YR × \$ 25.86/hr = $\underline{\$4720/YR}$

HTW SAVINGS:

CURRENT BOILER WATER CONCENTRATIONS ARE ABOUT 1/2 THE RECOMMENDED VALUE. THEREFORE BLOWDOWN CAN BE CUT IN HALF.

525600 GAL/YR × 0.50 = $\underline{262800 \text{ GAL/YR}}$

O&M Cost Savings

\$4720/YR × 0.5 = $\boxed{\$2360/YR}$

CAPITAL EXPENSE IS REQUIRED TO OBTAIN THIS SAVINGS.

Additional water analysis: 5 tests and reports × \$100 ea = $\underline{\$500}$

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | Existing Blowdown |
| ECO Number: | 2 |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/08/96

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Average heating fuel cost | $1.34 | /MBtu |
| 5. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

525600 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1359.7 MBtu/Yr

Heating Fuel Use = 1359.7 MBtu/yr / 0.68 = 1999.6 MBtu/Yr

Heating Fuel Cost = 1999.6 MBtu/yr x $1.34 /MBtu = $2,679 /Year

Water Cost:

525600 Gal/Yr x $0.5562 /kGal = $292 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,679 | /Year |
| Water Cost | $292 | /Year |
| Total Utility Cost | $2,971 | /Year |

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | Reduce Blowdown |
| ECO Number: | 2 |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/08/96

Assumptions:

1. HTW temperature — 380 °F
2. Make-up water temperature — 70 °F
3. Boiler efficiency — 68%
4. Average heating fuel cost — $1.34 /MBtu
5. Water cost — $0.5562 /kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

262800 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 679.9 MBtu/Yr

Heating Fuel Use = 679.9 MBtu/yr / 0.68 = 999.8 MBtu/Yr

Heating Fuel Cost = 999.8 MBtu/yr x $1.34 /MBtu = $1,340 /Year

Water Cost:

262800 Gal/Yr x $0.5562 /kGal = $146 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $1,340 | /Year |
| Water Cost | $146 | /Year |
| Total Utility Cost | $1,486 | /Year |

ANNUAL SAVINGS

HEATING FUELS = 2000 - 1000 = $\boxed{1000 \text{ MBtu/YR}}$

WATER COST = $292 - $146 = $\boxed{\$146\text{ /YR}}$

ECO-2

# Estimated Water Consumption Due to Blowdown

| Blowdown Point | Duration Est. (min) | | Pipe Dia. | Pipe Length | Pres. Drop | Flow | | | Average |
|---|---|---|---|---|---|---|---|---|---|
| | Est. #1 | Est. #2 | (in) | (ft) | (ft) | (gpm) | (gpd, #1) | (gpd, #2) | (gpd) |
| Intermittent (1) | | | | | | | | | |
| Heater #1 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #2 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #3 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| No. 4 Boiler | | | | | | | | | |
| East Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| Rear Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| East Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| Sub-total Intermittent Blowdown - Summer | | | | | | | 448 | 343 | 395 |
| Heater #4 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #5 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Additional Intermittent Blowdown - Winter | | | | | | | 201 | 83 | 142 |
| Continuous (2) | | | | | | | | | |
| Steam Drum | 1440 | 0 | 1/16 | 100 | 400 | 1.353 | 1948 | 0 | 974 |
| Total Blowdown - Summer | | | | | | | 2396 | 343 | 1369 |
| Total Blowdown - Winter | | | | | | | 2597 | 425 | 1511 |

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

# ENERGY PROJECT DOCUMENTATION

## Project Number and Title

ECO-3 Reduce soot blowing, install exit gas temperature indicator on Boiler No. 4.

## Project Funding Category

Low Cost/No Cost

## Contents

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 1

DESCRIPTION OF PROJECT AND WHY PROJECT IS RECOMMENDED

## ECO Number 3

Reduce soot blowing, install exit gas temperature indicator on the wood-fired boiler.

**Description**

This project consists of installing a simple thermometer in the hot gas duct between the boiler outlet and the air heater. The thermometer will provide an indication of the boiler exit gas temperature. Ideally, the exit gas temperature should be recorded in the control room so the operator can watch the rate at which the boiler is fouling. Operators should record the boiler exit gas temperature every hour and only activate the soot blowers when the exit gas temperature gets above a predetermined value. The boiler exit gas temperature will rise with increasing load so the operators should have a chart showing "clean boiler" exit gas temperature for a range of boiler loads.

The soot blowers should be cycled once when the exit gas temperature is 40 degrees F above the clean boiler temperature for the current boiler load. The exit gas temperature should decrease to the clean boiler value while the soot blowers are operating. The blowers should not be operated again until the boiler exit gas temperature is equal to or greater than 40 degrees F above the clean boiler temperature. When the boiler load is low it may take many hours to foul the tubes enough to warrant soot blowing. Soot blowing may become more frequent at higher loads.

Some of the solid products of combustion of wood accumulate on the heat absorbing surfaces of the boiler which hinders the heat transfer process. These accumulations are removed by blowing them away with a high pressure (80 psig) steam jet directed at the boiler tubes. Cleaning the tubes allows more heat to be absorbed by the boiler, reducing the boiler exit gas temperature and increasing the boiler efficiency.

The soot blowers from the wood-fired boiler are currently operated on a timed basis, two times per shift or six times per day regardless of need. Steam (water) used by the soot blowing operation is exhausted from the boiler via the stack so it is a system loss. Frequent soot blowing wastes valuable steam energy, particularly at low boiler loads. Blowing soot too often can also cause excessive tube erosion and possibly result in premature tube replacement. Proper soot blowing is the art of keeping boiler efficiency high without wasting steam energy and shortening tube life.

Soot blowing should be initiated primarily based on boiler exit gas temperature. High exit gas temperatures indicate that energy released by the fuel is not being absorbed through the dirty tube surfaces. Typically, a 40 degrees F rise in exit gas temperature is approximately equal to one percent in boiler efficiency. This "rule of thumb" is often used to determine when the boiler has become fouled with the solid products of combustion and the operation of the soot blowers should be initiated. There is currently no instrumentation that provides

an indication of boiler exit gas temperature.

There are two IK type soot blowers for the wood-fired boiler. The manufacturer, Diamond Power, estimates that 325 pounds of steam (39 gallons of water) are consumed each time a soot blower is operated at 80 psig. The total daily estimated steam consumption for soot blowing in the Number 4 boiler is 3,900 pounds, which is equal to about 470 gallons of water per day (0.33 GPM).

Boiler log data shows the air heater exit gas temperature remains nearly constant which means the boiler tubes are probably not fouled enough to cause the temperature to rise. The energy savings calculations and economic analysis assumes the soot blowing frequency can be reduced to one blow per shift. This would reduce the HTW losses due to soot blowing by approximately 50 percent or 235 GPD.

**Results**

| | |
|---|---|
| Construction Costs | $230 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0 |
| Heating Fuels (MBtu/Year) | 1,226 |
| Water (Gallons/Year) | 85,340 |
| Annual Energy Cost Savings | $1,640 |
| Annual Water Cost Savings | $50 |
| Savings to Investment Ratio (SIR) | 107 |
| Simple Payback (Years) | 0.14 |

**Recommendations**

Based on the life cycle cost analysis, this project is recommended. The boiler tubes that face the soot blower should be carefully inspected annually. This inspection should include a measurement of the tubes outer diameter with a micrometer to determine the rate of tube metal erosion. It is better to replace a tube that is near the end of its useful life than to have it fail during operation.

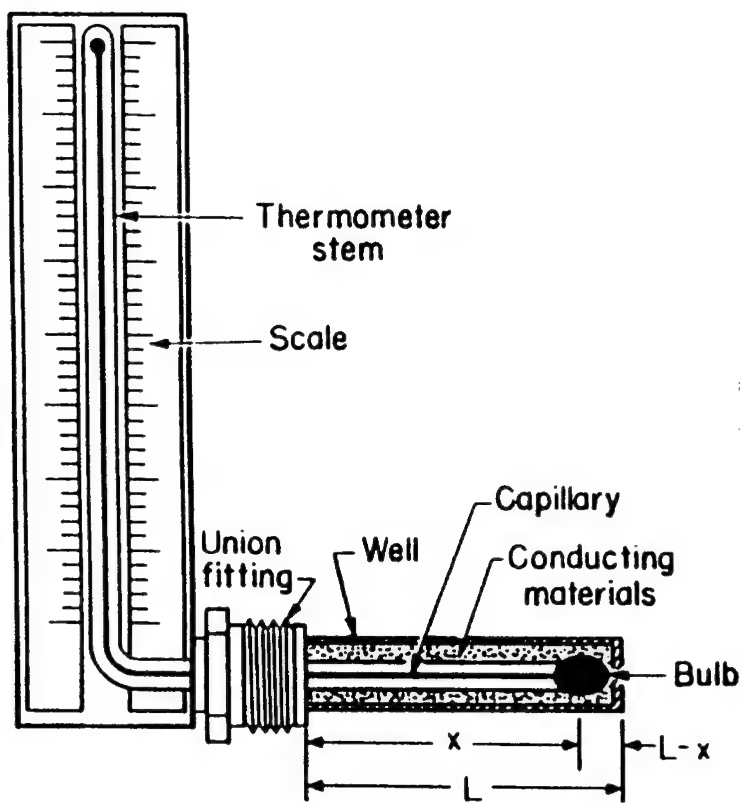
LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 2

SKETCH OF LOCATION AND/OR WORK REQUIRED

Sketch of Location and Work Required for ECO-3:

The work required involves installing a well and thermometer similar to the one shown in the sketch below. The well and thermometer should be installed in the most accessible location of the hot gas duct between Boiler Number 4 and the air heater.




**Industrial thermometer**

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 3

COST ESTIMATE AND BACK-UP DATA

ECO-3

# CONSTRUCTION COST ESTIMATE

Project: Reduce Soot Blowing
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 3

RS&H No.: 694-1331-002
Date: 05/24/96
Estimator: W.T.Todd
Filename: EST-3.WB2

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Thermometer well | 1 | Ea | 29 | 29 | 18.5 | 19 | 48 | MMp167 | MMp167 |
| Thermometer | 1 | Ea | 133 | 133 | 7.55 | 8 | 141 | MMp313 | MMp313 |
| Subtotal Bare Costs | | | | 162 | | 27 | $189 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 162 | | 27 | 189 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -12 | (12) | MMp533 | MMp533 |
| Subtotal | | | | 162 | | 15 | 177 | | |
| OH & Profit Markups | | | 10% | 16 | 53% | 8 | 24 | MMp7 | MMp475 |
| Subtotal | | | | 178 | | 23 | 201 | | |
| Sales Taxes | | | 4.0% | 7 | | NA | 7 | MMp476 | |
| Total Construction Cost | | | | 185 | | 23 | 208 | | |
| Design Fee | | | | NA | 6.0% | 12 | 12 | | |
| SIOH | | | | NA | 6.0% | 12 | 12 | | |
| Subtotal | | | | 185 | | 47 | 232 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 185 | | 47 | $232 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-3
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

| | | | |
|---|---|---|---|
| 1. INVESTMENT | | | |
| A. CONSTRUCTION COST | $ 208. | | |
| B. SIOH | $ 13. | | |
| C. DESIGN COST | $ 13. | | |
| D. TOTAL COST (1A+1B+1C) | $ 234. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 234. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1226. | $ 1643. | 14.88 | $ 24445. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1226. | $ 1643. | | $ 24445. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 47. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.88 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 699. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1690.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 25145.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 107.46
(IF < 1 PROJECT DOES NOT QUALIFY)

| | | | |
|---|---|---|---|
| **RS&H.** SUBJECT | Fort Stewart<br>Reduce Soot Blowing | AEP NO | 694 1331 002 |
| | | SHEET | OF |
| DESIGNER | G. Fallon | DATE | 2-8-96 |
| CHECKER | | DATE | |

ECO No. 3 DECREASE SOOT BLOWING FREQUENCY.

BOILER SOOT BLOWERS ARE OPERATED ONCE PER SHIFT REGARDLESS OF THE BOILER TUBE CLEANLINESS.

DIAMOND POWER (SOOT BLOWER MFGR) CALCULATES 325 LBS OF STEAM ARE CONSUMMED WITH EACH OPERATION THERE 2 BLOWERS ON NO.4 BOILER

CURRENT USE

$$\text{Energy} = 2 \text{ blowers} \times 325 \frac{\text{lb steam}}{\text{blow}} \times 2 \frac{\text{blows}}{\text{shift}} \times 3 \frac{\text{shift}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} = 1423500 \frac{\text{lb steam}}{\text{YR}}$$

$$1423500 \frac{\text{lb steam}}{\text{YR}} \times (1199.6 - (60-32)) \frac{\text{Btu}}{\text{lb}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = 1667.8 \frac{\text{MBtu}}{\text{YR}}$$

$$\text{Fuel} = 1667.8 \text{ MBtu/YR} \div 0.68 \text{ boiler eff.} = \underline{2453 \text{ MBtu/YR}}$$

$$\text{Water} = 1423500 \frac{\text{lb steam}}{\text{YR}} \div 8.34 \frac{\text{lb}}{\text{gal}} = \underline{170683 \text{ GAL/YR}}$$

\$95

DATA SHOWS EXIT GAS TEMPERATURE REMAINS NEARLY CONSTANT. IT IS THEREFORE REASONABLE TO ASSUME ~~THAT~~ THE BOILER ISN'T SUFFICIENTLY FOULED TO CAUSE EGT TO RISE. ASSUME THEREFORE THAT THE FREQUENCY COULD BE CUT IN HALF.

ANNUAL SAVINGS WOULD BE ABOUT 50%

ANNUAL SAVINGS

$$\text{Fuels} = 2453 \text{ MBtu/YR} \times 0.50 = \boxed{1226 \text{ MBtu/YR}}$$

$$\text{Water} = 170683 \text{ GAL/YR} \times 0.50 = \underline{85341 \text{ GAL/YR}}$$

$$\text{Water \$} = 85341 \frac{\text{GAL}}{\text{YR}} \times \$0.5562 / 1000 \text{ GAL} = \boxed{\$47/\text{YR}}$$

# ENERGY PROJECT DOCUMENTATION

**Project Number and Title**

ECO-9A Improve the start-up procedure for the SEP.

**Project Funding Category**

Low Cost/No Cost

**Contents**

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 1

DESCRIPTION OF PROJECT AND WHY PROJECT IS RECOMMENDED

## ECO Number 9

Reduce or eliminate HTW discharge during SEP start-up.

**<u>Discussion</u>**

The SEP operates only during the heating season. During start-up, high cascade heater levels are caused by an accumulation of condensed steam with no way to pump it back to the CEP. The current practice is to discharge the excess water at the SEP until the HTW temperature and pressure rise sufficiently to overcome the CEP cascade heater pressure.

Starting up the SEP at the beginning of the heating season results in an estimated loss of about 58,100 gallons of condensate and HTW.

**Option A. Improve Start-up Procedure for the SEP**

**<u>Description - Option A</u>**

Changing the start-up procedures can eliminate all of the HTW dumping and reduce the labor effort required to operate the SEP. This project option calls for adopting the following procedure to start-up the SEP:

1. Warm the main steam line.
2. Fully close the HTW return (inlet) valves at the cascade heaters.
3. Admit full steam pressure to the cascade heaters (the entire circulation system should now be at or near full steam pressure)
4. Start a circulation pump.
5. Slowly crack open both of the HTW return valves at the heaters until a 20 psig reduction in heater pressure is attained. The system pressure should be about 20 psig below steam pressure or about 150 psig.
6. As the water level rises in the heaters, start the HTW return pumps as necessary to maintain the heater levels within operating range. The return pump suction pressure should be sufficiently high when added to the pump head to overcome the line loss and static head at the CEP.
7. As the system temperature rises so also will the pressure in the heater. Continue to slowly open the HTW return valves at the heaters to keep the pressure at 150 psig. As the HTW nears normal operating temperature the HTW return valves may be fully opened. The SEP should now be fully operational.

At start-up, the entire SEP system is at ambient temperature. Circulation through the SEP HTW distribution system and the cascade heaters is established after the steam line from the CEP is warmed and ready for service. Steam is then admitted to the cascade heaters to begin warming the cold water. The HTW, which is still cold, is circulating at or near its full load circulation rate to allow the entire system to warm-up at an even rate. When the steam and water mix in the cascade heater, the quantity of cold water is so high relative to the steam available that the steam instantaneously condenses giving up its heat and volume to the cold water. Even with the steam valve wide open, the steam is condensed so quickly that the pressure in the system remains low for some time.

The pressure rises in the SEP as the water temperature rises and is equal to the saturation pressure for the temperature of the water in the SEP cascade heaters. The water level in the cascade heaters begins to rise due to the expansion of the heated water and the increased inventory from the condensed steam. The SEP return pumps do not have enough head to pump the excess water back through approximately one mile of pipe and also overcome the 200 psig pressure in the CEP cascade heaters. The cascade heaters get to their operating level before the pressure rises high enough to help push the excess water back to the CEP and it must, therefore, be thrown out.

**Energy and Economic Analysis**

The annual energy and water losses and cost were calculated by taking the total make-up water for the 11-day startup period during November 13-23, 1995 and subtracting the average make-up water use for the previous six months. An average temperature difference was used for the heating energy calculations since the HTW being discharged at the beginning of the start-up process is at the same temperature as the make-up water. There is also a significant amount of labor effort that must be invested each year while the SEP start-up is in progress.

**Results**

| | OPTION A |
|---|---|
| Construction Costs | $0 |
| Annual Utility Savings | |
| Electricity (MBtu/Year) | 0.3 |
| Heating Fuels (MBtu/Year) | 111 |
| Water (Gallons/Year) | 58,090 |
| Annual Energy Cost Savings | $150 |
| Annual Water Cost Savings | $30 |

| | OPTION A |
|---|---|
| Construction Costs | $0 |
| Annual O&M Cost Savings | $1,030 |
| Savings to Investment Ratio (SIR) | N/A |
| Simple Payback (Years) | N/A |

**Recommendations**

The plant operators should try the modified start-up procedure described in ECO-9 Option A.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 2

SKETCH OF LOCATION AND/OR WORK REQUIRED

Sketch of Location and Work Required for ECO-9A:

No sketch required. The location of this project is in the Central Energy Plant and in the Satellite Energy Plant. The work for this project is described in detail by Attachment 1 and involves operator labor only.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 3

COST ESTIMATE AND BACK-UP DATA

ECO-9A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-9
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 111. | $ 149. | 14.88 | $ 2213. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 111. | $ 153. | | $ 2275. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1220.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 18152.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT FORT STEWART
IMPROVE SEP START-UP
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-1-96
DATE

ECO-9 OPTION A

The SEP was started up from 13 NOV 95 - 23 NOV 95

The HTW system make-up water for those 11 days:

Actual HTW Make-up = 138,350 Gal.

Average HTW make-up for the previous 6 months:

$$\frac{(4.6 + 5.2 + 5.7 + 5.3 + 5.0 + 4.6)\text{ GPM}}{6} = 5.067 \text{ GPM}$$

$$\text{Average HTW Make-up} = 5.067 \frac{\text{GAL}}{\text{min}} \times 1440 \frac{\text{min}}{\text{day}} \times 11 \text{ days} = 80256 \text{ Gal}$$

Assuming the SEP start-up losses = Actual - Average:

$$\text{SEP Startup losses} = 138350 \text{ GAL} - 80256 \text{ GAL} = 58094 \frac{\text{GAL}}{\text{YR}}$$

O&M Cost (Assume start-up takes 4 hr/day & 10 days)

$$\text{Current startup Costs} = 10 \text{ days} \times 8 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$2069/\text{YR}$$

$$\text{Proposed startup costs} = 10 \text{ days} \times 4 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$1034/\text{YR}$$

$$\text{O\&M Savings} = \$2069 - \$1035 = \boxed{\$1035/\text{YR}}$$

$$\text{Proposed Operating Cost} = \$13163 - \$1035 = \$12128/\text{YR}$$

RS&H

SUBJECT FORT STEWART
AEP NO 694 1331 002
SHEET OF
DESIGNER W. Todd
DATE 2-1-96
CHECKER
DATE

ECO-9

Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for 4½ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35 mmp 475

Adjusted for Savannah GA = \$46.35 x 0.558 = \$25.86 mmp 533

Labor Costs:

Startup: $10 \frac{days}{yr} \times 8 \frac{hrs}{day} \times \$25.86/hr = \$2069/YR$

Operation: $4.5 \frac{mo}{YR} \times 30 \frac{day}{mo} \times 3 \frac{hr}{day} \times \$25.86/hr = \$10473/YR$

Shut down: $3 \frac{day}{YR} \times 8 \frac{hr}{day} \times \$25.86/hr = \$621/YR$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \$13163/YR

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Improve SEP Start-up Procedure | Date: | 02/12/96 |
| ECO Number: | 9 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x $1.34 /MBtu = $148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

58094 Gal/Yr x $0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $148 | /Year |
| Pumping (Elec) Cost | $4 | /Year |
| Water Cost | $32 | /Year |
| Total Utility Cost | $184 | /Year |

ECO-9A

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 4020 | | | 2.8 | |
| | 2 | 5090 | | | 3.5 | |
| | 3 | 3730 | | | 2.6 | |
| | 4 | 7330 | | | 5.1 | |
| | 5 | 2280 | | | 1.6 | |
| | 6 | 7650 | | | 5.3 | |
| | 7 | 2440 | | | 1.7 | |
| | 8 | 3700 | | | 2.6 | |
| | 9 | 9110 | | | 6.3 | |
| | 10 | 10140 | | | 7.0 | |
| | 11 | 5410 | | | 3.8 | |
| | 12 | 6830 | | | 4.7 | |
| | 13 | 10080 | | | 7.0 | |
| | 14 | 9320 | | | 6.5 | |
| NOV | 15 | 12200 | | 8708 | 8.5 | 6.0 |
| | 16 | 13450 | | | 9.3 | |
| | 17 | 16220 | | | 11.3 | |
| | 18 | 14560 | Total = 138,350 | | 10.1 | |
| | 19 | 10130 | | | 7.0 | |
| | 20 | 13380 | | | 9.3 | |
| | 21 | 14530 | | | 10.1 | |
| | 22 | 14460 | | | 10.0 | |
| | 23 | 10020 | | | 7.0 | |
| | 24 | 7950 | | | 5.5 | |
| | 25 | 11720 | | | 8.1 | |
| | 26 | 4100 | | | 2.8 | |
| | 27 | 4450 | | | 3.1 | |
| | 28 | 10070 | | | 7.0 | |
| | 29 | 9450 | | | 6.6 | |
| | 30 | 7410 | 261230 | | 5.1 | |
| | 1 | 7430 | | | 5.2 | |
| | 2 | 9300 | | | 6.5 | |
| | 3 | 10090 | | | 7.0 | |
| | 4 | 8930 | | | 6.2 | |
| | 5 | 9170 | | | 6.4 | |
| | 6 | 6500 | | | 4.5 | |
| | 7 | 9930 | | | 6.9 | |
| | 8 | 7770 | | | 5.4 | |
| | 9 | 7430 | | | 5.2 | |
| | 10 | 9410 | | | 6.5 | |
| | 11 | 9100 | | | 6.3 | |
| | 12 | 8010 | | | 5.6 | |
| | 13 | 9780 | | | 6.8 | |
| | 14 | 9470 | | | 6.6 | |
| DEC | 15 | 10930 | | 8371 | 7.6 | 5.8 |
| | 16 | 8650 | | | 6.0 | |
| | 17 | 9770 | | | 6.8 | |
| | 18 | 8500 | | | 5.9 | |
| | 19 | 6790 | | | 4.7 | |
| | 20 | 7300 | | | 5.1 | |
| | 21 | 7620 | | | 5.3 | |
| | 22 | 4110 | | | 2.9 | |
| | 23 | 6220 | | | 4.3 | |
| | 24 | 7180 | | | 5.0 | |
| | 25 | 4420 | | | 3.1 | |
| | 26 | 5050 | | | 3.5 | |
| | 27 | 7010 | | | 4.9 | |
| | 28 | 9310 | | | 6.5 | |
| | 29 | 10690 | | | 7.4 | |
| | 30 | 11030 | | | 7.7 | |
| | 31 | 12610 | 259510 | | 8.8 | |

# OPERATING INSTRUCTIONS

## CASCADE WATER HEATER

### I. DESCRIPTION

The Chicago Heater Company cascade hot water heater has been specifically designed to handle all of the system returns outlined in the contract specifications. In order to insure the most efficient use of steam pressure and energy level in the cycle and the lowest operating cost, these specified design rates of flow should not be exceeded.

The cascade heater is a direct contact heat exchanger, heating in such a machine is achieved by passing carefully controlled streams of water through a steam atmosphere.

### II. OPERATION

System returns enter the cascade heater through the water inlet nozzle provided on the shell. These returns are conveyed upward through ducting within the unit to a distributor weir over which they cascade downward on to specially designed water distributing trays. These trays break up the water into thin streams to expose the greatest surface area to the steam which fills the heating section. In the steam space the water is heated to within 10° of the steam temperature. The hot water leaving the heating element falls into the storage compartment and is ready for service.

### III. BEFORE START UP

This equipment should not be started until all operating personnel are familiar with the start up procedures herein outlined. Particular attention should be paid to the operation of the various controls furnished with the cascade heater.

Prior to admitting water and steam to the unit, the following equipment should be checked.

A. The atmospheric vent should be wide open. Note: At low starting loads it may be necessary to throttle this valve slightly to bring the unit up to pressure, but in no case is the valve to be fully closed.

B. The relief valve should be checked to be certain that gags and shipping stops have been removed.

C. Manually operate all controls. Control valves should be checked for correct travel, freedom from friction, and correct action to match their controlling instrument. For successful operation, the actuator stem and valve plug stem must move freely in response to loading pressure changes on the diaphragm.

D. Alarm switches should be checked to be certain that the switches are installed for proper function and alarm devices are operational.

E. Thermometer, pressure gauges, and all recording instruments should be properly calibrated.

## IV. START UP

The following procedures should be followed when commencing operation of the cascade heater after all equipment has been tested and checked.

1. Flush out all lines and tanks with water until there is no apparent indication of foreign matter or rust.

2. Close outlet valve from heater to feed pumps.

3. Start flow of inlet water and slowly increase from 50 to 60 per cent of design rate.

4. Open valve admitting steam into tank slowly. Possibly some rumbling may occur but this may be disregarded with the cold tank. Check steam gauge in the heater and make absolutely certain that positive steam pressure is maintained in the heater; if steam supply is insufficient, utilize other sources such as live steam through a reducing valve or any other auxiliary steam supply.

5. Filling the vessel with water will purge most of the air from the tank. As the water approaches operating level, increase the steam flow. Caution: Filling the tank with steam and then flooding with cold water subjects the tank to undue stresses caused by vacuum created by rapid condensation. Never fill the vessel with steam and admit cold water.

6. As the water reaches the operating level, check the operation of inlet controllers. Make adjustments at all controllers. Manually continue the flow of water until high level controls operate. Check operating level of controllers and alarms at this point.

7. When a considerable volume of steam is issuing from the vent valve, commence throttling back vent valve until only a plume of vapor can be seen issuing from it. At this point the water temperature within the unit whould be within 10° of saturation temperature of steam at heater pressure. A lower water temperature indicates that pockets of air have left and completely purged. If this occurs, open steam valve wide, then open vent valve wide for a few seconds, then throttle back to force pockets to the vent.

8. Open steam valve wide.

9. The unit is now ready for service and the outlet valve may be opened and admit water to the feed pumps. When the unit is operating correctly, the storage water temperature should be within 10° of the saturated temperature of the steam at heater pressure.

10. For any special equipment that has been supplied with this unit, check the descriptive literature and operating instructions for that equipment.

# ENERGY PROJECT DOCUMENTATION

**Project Number and Title**

ECO-12A Reduce boiler and HTW system operating pressure to 100 psig.

**Project Funding Category**

Low Cost/No Cost

**Contents**

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 1

DESCRIPTION OF PROJECT AND WHY PROJECT IS RECOMMENDED

## ECO Number 12

Reduce boiler and HTW system operating pressure.

**Discussion**

When the No. 4 boiler was initially installed, the system was operated at approximately 225 psig. This might be because the boiler was designed for that pressure and performance guarantees made by the manufacturer required design operating conditions to demonstrate contractual compliance. Soon after start-up, it was determined that the circulating pump seals were failing too frequently. To increase the seal life, the operating pressure on the entire system was reduced to its current level. The boilers and HTW system are currently operated at about 180 psig and the corresponding saturation temperature of 380 degrees F.

During the non-heating season, the energy requirement on the system is rather low. Unit No. 4 carries the whole load which rarely exceeds 50 percent boiler capacity. Heating requirements during this time are limited to domestic hot water in the barracks and dining facilities and autoclave operation at the hospital. Pressure requirements are limited to soot blowing on the No. 4 boiler where the blower set pressure is 80 psig.

A study of underground piping heat losses completed at Ft. McClellan, Alabama showed a heat transfer rate of 55 Btu/Hr-LF for pipes with dry insulation. Pipes with deteriorated and moist insulation had a heat transfer rate of about 275 Btu/Hr-LF. These heat transfer rates were applied to the Fort Stewart HTW piping. The heat loss calculations assumed approximately one-half of the pipes have deteriorated and/or moist insulation. This assumption was based on observations of the pipes in the valve pits and steam flow from the conduit vents. It was also assumed that the heat transfer losses are proportional to the temperature difference between the fluid and the surrounding soil. The calculations yielded a current annual HTW distribution system heat loss of about 160,000 MBtu which required a heating fuel input of about 235,300 MBtu/Year.

Reducing the boiler and HTW system operating pressure and temperature will reduce the heat losses from the system to the surroundings. Operating at lower pressures will result in less stress on the system components; however, the O&M savings would be impossible to estimate with any confidence. Therefore, O&M savings are not included in the economic analysis.

**Option A: Reduce Boiler and HTW System Pressure to 100 psig.**

**Description - Option A**

All that is necessary to accomplish this option is to slowly reduce the CEP plant master pressure controller from 180 psig to 100 psig.

**Analysis - Option A**

Steam is currently produced at a pressure of about 180 psig which heats the HTW to 380 degrees F. Reducing the operating pressure to 100 psig would reduce the operating temperature to 338 degrees F and the heat transfer losses from the HTW distribution piping to the surroundings would be reduced by approximately 20,566 MBtu/Year. Assuming a boiler efficiency of 68 percent results in a heating fuel savings of 30,244 MBtu/Year.

**Results**

| | OPTION A |
|---|---|
| Construction Costs | $0 |
| Annual Utility Savings (Increase) | |
| Electricity (MBtu/Year) | 0 |
| Heating Fuels (MBtu/Year) | 30,244 |
| Fuel Oil (MBtu/Year) | 0 |
| Water (Gallons/Year) | 0 |
| Annual Energy Cost Savings | $40,530 |
| Savings to Investment Ratio (SIR) | N/A |
| Simple Payback (Years) | N/A |

**Recommendations**

Based on the energy savings calculations, Option A should be implemented and the operating pressure of the CEP and the HTW should be reduced to 100 psig immediately. No capital cost is required to make this change. All that is necessary is to slowly reduce the CEP plant master pressure controller from 180 psig to 100 psig.

If the end use systems cannot maintain the desired temperatures during the winter months, the pressure can be adjusted up until all requirements are satisfied.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 2

SKETCH OF LOCATION AND/OR WORK REQUIRED

Sketch of Location and Work Required for ECO-12A:

No sketch required. The location of this project is in the control room of the Central Energy Plant. The work for this project is described in detail by Attachment 1 and involves operator labor only.

LOW COST/NO COST PROJECT DOCUMENTATION

ATTACHMENT 3

COST ESTIMATE AND BACK-UP DATA

ECO-12A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
STUDY: ECO-12
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ | 0. |
| B. SIOH | $ | 0. |
| C. DESIGN COST | $ | 0. |
| D. TOTAL COST (1A+1B+1C) | $ | 0. |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ | 0. |
| F. PUBLIC UTILITY COMPANY REBATE | $ | 0. |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | $ | 0. |

****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 30244. | $ 40527. | 14.88 | $ 603041. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 30244. | $ 40527. | | $ 603041. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 40527.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 603041.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT: FORT STEWART REDUCE OPERATING PRESSURE
DESIGNER: G. Fallon
CHECKER:
AEP NO: 694 1331 002
SHEET: 1 OF
DATE: 2-13-96
DATE:

ECO-12 REDUCE HTW PRESSURE

OPTION A. REDUCE PRESSURE FROM 180 TO 100 PSIG

SATURATION TEMPERATURE FOR 180 PSIG = 379°F
" " " 100 " = 338°F

TOTAL LINEAL FT OF PIPE = 121737 FT
LINEAL HEAT LOSS GOOD PIPE = 55 BTU/FT (see attached)
" " " BAD PIPE = 275 BTU/FT (" ")
ASSUME 1/2 OF THE PIPE IS GOOD & 1/2 IS BAD.
SEP LINEAL FT OF PIPE = 17,500 FT

ENERGY SAVED IN HTW DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(338-60)}{(379-60)}\right) \times (121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/HR\cdot FT \times 8760\,H/yr}{1E6\ BTU/MBTU}$$

$= 19,364$ MBTU/yr

$$Q_{SEP} = \left(1-\frac{(338-60)}{(379-60)}\right) \times 17500\ ft \times \frac{275-55}{2}\,BTU/HR\cdot FT \times 135\ D/yr \times 24\ H/D$$

$= 1202$ MBTU/yr

$$Q_{TOT} = \frac{Q_{CEP}+Q_{SEP}}{0.68}$$ NOTE: ASSUME 68% BOILER EFF.

$$= \frac{(19364+1202)\ MBTU/yr}{0.68} = \frac{20.566}{0.68}\ MBtu/YR$$

$$= \boxed{30,244\ MBTU/yr}$$

NOTE: THIS OPITION CAN BE IMPLEMENTED IMMEDIATELY BY RESETTING THE CEP STEAM PRESSURE MASTER CONTROL SET POINT TO 100 PSIG.

ANNUAL SAVINGS

$\$ = 30,244$ MBTU/yr $\times$ 1.34 \$/MBTU
$= 40,527$ \$/yr

RS&H

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 7 OF
DATE 2-13-96
DATE

CURRENT PIPING ENERGY LOSS

$Q_{CEP} = (121737 - 17500)\text{ft} \times (275+55)/2 \text{ BTU/HR}\cdot\text{ft} \times 8760$
$\quad 104237 \times 165 \times 8760$
$= 150{,}664 \text{ mBTU/yr}$

$Q_{SEP} = (17500)\text{ft} \times (275+55)/2 \text{ BTU/HR}\cdot\text{ft} \times 135 \times 24$

$= 9355 \text{ mBTU/yr}$

$Q_{TOT} = 150{,}664 \text{ mBtu/YR} + 9355 \text{ mBtu/YR} = 160019 \text{ mBtu/YR}$

Current fuel use $= 160{,}019 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{235{,}322 \frac{\text{mBtu}}{\text{YR}}}$